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Power Saws: A Review of Injury Data and Power Saw Industry Survey

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Final Report

Prepared for:
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U.S. DEPARTMENT OF COMMERCE, Rogers C.B. Morton, Secretary
NATIONAL BUREAU OF STANDARDS, Richard W. Roberts, Director

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Summary

This document is the final report of an investigation of power saws performed for the Consumer Product Safety Commission (CPSC). Two activities of the project are described herein: a review of power saw injury data and two surveys of power saw manufacturers' individual opinions concerning safety aspects of saw use and design. These surveys dealt with portable circular saws and table and radial arm saws.

The injury data reviewed consisted of information from the National Electronic Injury Surveillance System (NEISS) and from In-Depth Investigation Reports compiled by CPSC. The great majority of power saw related injuries involved lacerations or amputations of the fingers or hands of males over 15 years of age. The most detailed information about the patterns of saw accidents was available for unspecified stationary saws and portable circular saws. The most frequently reported accident patterns involving stationary saws were "kickbacks," "hand in line with blade" and "reaching over blade." For portable circular saws the two most often reported accident patterns involved "kickbacks" and "guard malfunctions."

The two opinion surveys developed and administered by NBS were directed toward obtaining the opinions of technical representatives of power saw manufacturers on five major areas of saw use and design, i.e., electrical safety, blade contact hazards and prevention, accidental starting of the saw, the design of various saw components and the judged adequacy of saw instruction manuals. Power saw engineers and designers recognize some problems with present saw designs, most notably these include the problems associated with kickbacks. On the whole, however, those surveyed believe saws to be reasonably free from hazards introduced by product design. The area in which the saw manufacturers believe the most hazards to exist is that of the operator's use of power saws. The human element in power saw accidents is recognized as a major contributor to saw related injuries, but little is known about how to assure that safe practices will be followed. Areas for further study are suggested.

1.0 Introduction

This document is the final report of an investigation of power saws conducted by the National Bureau of Standards (NBS) for the Consumer Product Safety Commission (CPSC). The major effort of the project was the development, administration and analysis of two opinion surveys directed toward the manufacturers of (1) portable circular saws and (2) table and radial arm saws. Also included in the report is a summary hazard analysis based on data provided by CPSC. Much of the information presented in this hazard analysis has been reported previously in a progress report.[1]

Since its inception in January 1974, the power saw study has undergone several modifications in both direction and scope. As initially conceived, this investigation was to encompass the identification of power saw hazards and the evaluation of design characteristics, operator safety practices, work space conditions and educational requirements for safe power saw use. To this end, a four phase study was designed. The first phase was an analysis of injury data to identify the major hazards and hazardous behaviors associated with documented power saw accidents. The next three phases of study were to consist of progressively more structured and controlled observations of power saws in use, beginning with unobtrusive observations under relatively natural conditions and culminating in controlled laboratory observations focusing on specific hazards of saw operation and, possibly, design alternatives.

Coincident with the initiation of the first phase of the formal investigation, a variety of activities were pursued to acquaint project personnel with saw use and design. These included informal consultation with professional carpenters, woodworking instructors, saw retailers and, perhaps most importantly, the development of a working relationship with the Power Tool Institute (PTI). The PTI is a major trade organization of power tool manufacturers. Included in its membership are approximately 90 percent of the portable saw manufacturers in the United States and a large proportion of stationary saw manufacturers. Repeated contact with members of PTI's Safety and Engineering Committees proved invaluable in facilitating the learning process required by project staff. During this initial effort, current voluntary standards were also reviewed.

The first phase of saw observations was initiated at several locations including high school woodworking classes, apprentice carpenter training sessions and a walk-in military hobby shop. Approximately 10 hours of video tape recordings were produced from these sessions. Content analysis of the tapes, directed toward identifying hazardous behaviors associated with saw use, was initiated. Before completion, however, NBS was requested by CPSC to change the direction of the investigation. These requests resulted from a variety of considerations including fiscal matters, modifications in CPSC priorities and the ethical and legal ramifications related to the

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[1] Quarterly Report, Project 21, Power Saws, April 1, 1974.

use of human subjects. In another instance NBS was requested to stop all ongoing activities in order to develop a response to a petition addressed to the Commission concerning the owner's manuals which accompany power saws. This request was met by the transmittal of two memo reports to the CPSC project monitor.[1]

Negotiations relating to the status of the project led to narrowing the project scope to one primary task, namely the development, administration, and analysis of the two surveys of manufacturers' opinion. These surveys were designed to elicit opinions on a variety of issues concerned with safety aspects of the design and use of power saws. Topics addressed in the surveys included electrical safety, blade contact, accidental activation, design of saw components and the adequacy of instruction manuals. The bulk of this report deals with the survey results.

To assist the reader who may be unfamiliar with the terminology employed in the saw industry and with the operations and components of power saws, a brief glossary of important terms has been included in Appendix A. Also included in this appendix are illustrations showing the major components of portable circular, table and radial arm saws.

2.0 Hazard Analysis

A review of power saw accidents was made to provide information relevant to the types of power saws reported to be involved in accidents, the kinds of injuries sustained and the accident patterns involved. The data reviewed were provided by CPSC and consisted of summaries of 282 In-Depth Investigation Reports (IDIRs) and National Electronic Injury Surveillance System (NEISS) data for FY 1973.

2.1 National Electronic Injury Surveillance System Data

Power saw accidents reported in NEISS are classified in four product categories: power saws, not otherwise specified; power saws, portable, not circular; power saws, stationary; and powered, portable circular saws. A total of 1,483 incidents of personal injuries were reported in FY 1973 in these categories. The majority of these, 1,114 cases (75 percent), involved tools classified as unspecified power saws. Stationary and non-circular portable saws each accounted for 140 (9.4 percent of the reported accidents and portable circular saws 89 (6 percent) accidents. In light of the wide variety of power saws available, these data provide little in terms of identifying specific saw types which have been involved in accidents. There is no way of ascertaining what types of saws were included in the unspecified category. Furthermore, even the more specific categories likely include a broad range of saw types which are substantially different from each other in both function and design. Thus, for example, radial arm, table and some jig saws may all be classified as stationary saws even though they exhibit marked differences in operation and design.

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[1]Power Saw Instruction Manuals, May 23, 1974, and June 24, 1974.

The NEISS data do provide information on the age and sex of accident victims, body parts injured, injury diagnosis and location at which the accident occurred. These data are presented in Tables 1-3 for all saw classifications combined. The data for each category separately are presented in Appendix B. The overwhelming majority, 94.9 percent, of the victims was male. Less than 10 percent of the victims were under 15 years old. In terms of body part injured and injury diagnosis, lacerations of the fingers were by far the most common injury sustained, accounting for 60.3 percent of all saw injuries. Hand and finger injuries account for 75 percent of all reported saw injuries when the 59 incidents diagnosed as amputated fingers and the 159 cases of lacerated hands are added to these figures. Injuries which involved lacerations or amputations of any body part constituted 88.9 percent of all saw injuries. One diagnostic category in which there is a somewhat surprising lack of reported cases is electric shock. Of 1,483 injuries associated with power saws, only one incident of electric shock was reported. While this may be indicative of the electrical safety of power saws, there is a possibility that electric shock injuries were under reported. Since all of the accident data reviewed were reported by hospital emergency rooms, data on two important degrees of electric shock may have been lost. Relatively mild shocks which resulted in immediate pain but required no medical attention could indicate potentially hazardous saws which the accident data do not reveal. Similarly, any fatalities due to shock would likely not be reported. Although NEISS injury data do not include industrial or occupational injuries, a few injuries were reported as occupational. These may have been injuries sustained by professional saw users at locations other than an industrial installation, such as capenters working at private residences. The only locations other than the home in which a substantial number of accidents were reported occurred are listed in Table 3 as "other public" locations. Slightly over 10 percent of the accidents were reported as happening at these locations which include schools, public recreation facilities and institutions.

2.2 In-Depth Investigation Reports Summary Data

The information from 282 IDIR summaries provide some additional insight into power saw accidents. A summary of the data culled from the IDIR summaries is presented in Tables 4-6. The value of these data lies not in the precise numbers of incidents reported but rather in the charactization of the patterns of saw accidents. It is important to note in this regard that the IDIR data base is not a statistically representative base. Table 4 shows the distribution of the accident victims' age and sex. Table 5 presents the body part injured and injury diagnosis data. Overall these data are not markedly dissimilar from the corresponding data reported in NEISS. Thus, the vast majority of victims were male and the bulk of the injuries were lacerations and amputations of fingers and hands. The NEISS and IDIR data do differ in terms of the proportion of amputations reported. While only 4 percent of the incidents reported to NEISS involved amputations, 19.5 percent of the IDIRs were so diagnosed. Another area in which the NEISS and IDIR data differ importantly is in the distribution of saw types involved in reported injuries. Only 6 percent

TABLE 1

Distribution of Power Saw Accident Victims By Age and Sex
All Types of Saws Combined
(NEISS, FY 1973)

Age	Male	Female	Total	Percent of Distribution	Percent of U.S. Population**
0-4	12	1	13	0.9	8.4
5-14	108	18	126	8.5	20.0
15-24	311	19	330	22.5	17.4
25-34	264	10	274	18.5	12.2
35-44	223	7	230	15.5	11.4
45-54	188	10	198	13.4	11.4
55-64	154	7	161	10.9	9.2
65+	147	4	151	10.2	9.9
Total	1407	76	1483	*	*
Percent of Distribution	94.9	5.1	100		

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 2

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
All Types of Saws Combined
(NEISS, FY 1973)

	Diagnosis						
Body Part Injured	Laceration	Amputation	Electric Shock	Fracture	All Others	Total	Percent of Distribution
Hand	159	0	0	2	5	166	11.2
Finger	894	59	0	45	60	1058	71.3
Arm	40	1	0	0	6	47	3.2
Upper Leg	45	0	0	0	2	47	3.2
Lower Leg, Foot, Toe	88	0	0	4	10	102	6.9
Trunk	12	0	0	2	5	19	1.3
Eye	1	0	0	0	18	19	1.3
Head and Neck	19	0	1	0	5	25	1.7
Total	1258	60	1	53	111	1483	*
Percent of Distribution	84.8	4.0	0.1	3.6	7.5	*	

* Percentages do not necessarily add to 100% due to rounding error.

TABLE 3

Distribution of Power Saw Accidents By Location and Saw Type
(NEISS, FY 1973)

Location	Unspecified Saws	Portable Non-Circular	Stationary	Portable Circular	Combined	Percent of Distribution
Home	766	105	82	67	1020	68.8
Occupational	8	2	3	1	14	.9
Farm	2	3	0	0	5	.3
Highway/Street	3	0	0	1	4	.3
Other Public	102	16	31	5	154	10.4
Unknown	233	14	24	15	286	19.3
Total	1114	140	140	89	1483	*
Percent of Distribution	75.0	9.4	9.4	6	*	

* Percentages do not necessarily add to 100% due to rounding error.

TABLE 4

Distribution of Power Saw Accident Victims By Age and Sex
(282 IDIR Summaries)

Age	Male	Female	Total	Percent of Distribution	Percent Reported in NEISS	Percent of U.S. Population**
0-4	0	0	0	0	0.9	8.4
5-14	18	1	19	6.7	8.5	20.0
15-24	47	2	49	17.4	22.5	17.4
25-34	48	1	49	17.4	18.5	12.2
35-44	41	3	44	15.6	15.5	11.4
45-54	52	2	54	19.1	13.4	11.4
55-64	33	0	33	11.7	10.9	9.2
65+	34	0	34	12.0	10.2	9.9
Total	273	9	282	*	*	*
Percent of Distribution	96.8	3.2	100			
Percent Reported in NEISS	94.9	5.1				

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 5

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
(282 IDIR Summaries)

Body Part	Diagnosis					Percent Reported in NEISS	Percent of Distribution
	Lacerations	Amputation	Fractures	Other	Total		
Hand	15	0	0	1	16	11.2	5.7
Fingers	164	50	16	7	237	71.3	84.0
Legs	21	0	0	0	21	**	7.4
Eyes	1	0	0	1	2	1.3	.7
Not specified	0	5	0	1	6	**	2.1
Total	201	55	16	10	282		*
Percent of Distribution	71.3	19.5	5.7	3.5	100		
Percent Reported in NEISS	84.8	4.0	3.6	7.5	*		

* Percentages do not necessarily add to 100% due to rounding error.
** No equivalent category for NEISS data.

TABLE 6

Distribution of Accident Patterns By Saw Type
(282 IDIR Summaries)

Accident Pattern	Saw Type: Unspecified Stationary	Portable Circular	Radial Arm	Jig or Band	Portable Non-Circular	Others	Total	Percent of Distribution
Kickback	36	20	1	0	1	4	62	22.0
Hand in line with blade	33	3	2	4	1	1	44	15.6
Reaching over blade	31	9	0	1	0	0	41	14.5
Guard malfunction	2	19	0	0	0	0	21	7.4
Distracted from task	12	3	1	0	0	1	17	6.0
Moving materials	11	2	1	1	0	0	15	5.3
Hand below cutting level	2	5	6	0	0	0	13	4.6
Hand slipped	10	1	0	1	0	0	12	4.2
Saw inadvertantly started	0	9	0	0	0	0	9	3.2
All others	14	20	1	3	7	3	48	17.0
Total	151	91	12	10	9	9	282	*
Percent of Distribution	53.5	32.3	4.2	3.5	3.2	3.2	*	

* Percentages do not necessarily add to 100% due to rounding error.

of the accidents reported to NEISS involved portable circular saws while over 32 percent of the IDIR summaries deal with portable circular saws. Similarly, accidents involving non-circular portable saws comprise 9.4 percent of the NEISS data and only 3.2 percent of the IDIRs.

An effort was made to extract from the IDIR summaries information concerning the types of sawing operations engaged in at the time of the accident. Unfortunately, nearly half (46.4 percent) of the summaries include reports of unspecified cutting or related activities. Of the remaining incidents, the most commonly reported operation was ripping, i.e., cutting with the grain of wood (24.1 percent). It is unknown whether ripping appears more frequently than other operations because it is inherently more hazardous or because it is one of the most commonly performed sawing tasks. Most of the experienced saw users and manufacturers consulted did agree that kickbacks were most likely to occur when ripping. All other specified sawing operations (e.g., bevel, crosscutting) are represented by less than 10 percent of the IDIR summaries.

The most important facets of the IDIR data are shown in Table 6. Data in this table show the accident pattern of the reported incidents for each saw type. The IDIR summaries provided somewhat more detailed information on the types of saws in accidents than did the NEISS. Caution must still be used in interpreting these data. For example, the category "unspecified stationary saws" probably includes a wide variety of stationary saws. While most of these saws are table or bench saws, an unknown number may be other types. The "accident patterns" specified in Table 6 offer a concise statement of the event or condition which precipitated the injury. The accident patterns presented here were identified by CPSC. It should be noted that these patterns may not be mutually exclusive.

2.2.1 Stationary Saws

For incidents involving stationary saws, the most prominent accident patterns to merge from the IDIRs were "kickbacks," "hand in line with blade" and "reaching over the blade." Kickbacks can occur under several conditions. Most commonly a kickback occurs when the kerf closes behind the blade, thereby pinching the blade. The energy from the blade is then transferred very quickly and usually unexpectedly from cutting through the work to violently throwing it back toward the operator. A similar result can be obtained if wood is fed into the blade from the wrong side. As a result of consultation with PTI and other experienced saw users, it has been learned that a variety of circumstances can increase the probability that a kickback will occur. These include sawing badly warped or bowed wood and improperly using a rip fence as a cut-off stop when crosscutting. It is unknown what conditions prevailed in the majority of IDIR incidents reported as kickbacks.

Accidents in which the victims' hands were in line with the blade appear to have been the result of the operator inadvertantly pushing the hand or fingers through the blade along with the workpiece. Reaching over the

blade occurred most often when the operator attempted to remove previously cut pieces or scrap from the rear of the saw table without turning off the saw motor or waiting for the blade to stop rotating. It is not clear in most of the accidents reported above whether or not a properly functioning blade guard was in place at the time of the incident. The missing data are important since a properly used, well designed guard may have prevented blade contact in many of these incidents. Without this information it is impossible to attribute the occurrence of the accident to saw design or operator error.

2.2.2 Portable Circular Saws

Portable circular saws were involved in incidents having somewhat different accident patterns than were stationary saws. Kickbacks were again the most prominent pattern. While the causes of kickbacks may be quite similar to those for stationary saws, the result is typically different. Instead of the wood being kicked back at the operator, the saw itself is often pushed violently out of the work. Guard malfunctions appear equally as important a factor as kickbacks in portable saw accidents. The guard involved here is the retractable lower guard. This guard, when functioning properly, closes over the bottom of the blade when removed from the work. The Underwriters Laboratory standard (UL45)[1] to which most American saws conform specifies that retraction of the lower guard should be accomplished within 0.3 seconds. It is not known whether the saws involved in accidents described as guard malfunctions met this standard nor is the exact nature of the malfunction specified for these incidents.

Two other accident patterns emerge quite often in portable circular saw incidents. These are "reaching over the blade" and "inadvertantly starting the saw." It is not clearly specified in the IDIR summaries what is meant by "reaching over the blade." Given the design of common portable saws, however, it is likely that these incidents might be more accurately described as having a hand in line with the blade since the top portion of the blade is covered at all times with a permanently fixed guard. Inadvertantly starting the saw directly involves the design of the saw handle and grip and the location of the power switch, as well as the operation required to activate the switch.

2.3 Summary

The review of power saw accident data provided some valuable insights concerning power saw accidents. As might be expected, the great majority of injuries involved lacerations or amputations of the fingers or hands of males over 15 years of age. Seventy five percent of the injuries reported to the NEISS involved power saws which were not specified as to type. The IDIR summaries did provide some additional information relevant to specific

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[1]Standard for Portable Electric Tools, UL45. Fourth Edition, April 15, 1974, Underwriters Laboratories, Inc.

saw types. These data, however, are not based on a known population of accidents. The most detailed information was available for unspecified stationary saws and portable circular saws. The former category includes many types of stationary saws but most predominant among these are table saws. Three accident patterns accounted for two thirds of the stationary saw accidents reported in the IDIRs. These were "kickbacks," "hand in line with blade," and "reaching over blade." Each of two accident patterns, kickbacks and guard malfunctions, accounted for slightly more than 20 percent of the injuries with portable circular saws. Nearly half (46.4 percent) of the saw accidents reported through the IDIRs involved unspecified cutting operations or related activity and more incidents occurred while ripping (24.1 percent) than were reported for any other specified sawing operation.

3.0 Power Saw Surveys

The major effort of the power saw study performed by NBS has been invested in the development, administration and analysis of two opinion surveys directed toward technical representatives of manufacturers of portable circular saws and table and radial arm saws. These surveys were developed after a long process of familiarization with the products currently on the market, review of CPSC accident data, observations of power saws in use and meetings with representatives of the Power Tool Institute.

The specific questions asked in the surveys were designed to elicit opinions from saw designers and engineers about safety aspects of saw design and use. Respondents were selected in cooperation with PTI and consisted of members of PTI's Engineering Committee. Every member company has at least one representative on this committee. Approximately 90 percent of the portable circular saw manufacturers in the United States are members of PTI and 85 to 95 percent of the table and radial arm saw consumer market is accounted for by PTI member companies. A total of 19 surveys were sent to portable saw manufacturers and four to makers of table and radial arm saws. Of the 19 portable saw surveys mailed out, 14 were returned completed, two were returned uncompleted because the companies no longer manufacture circular saws and three were returned not completed for other reasons. The respondents to the portable saw survey are all professional engineers involved in saw design or research and development. The respondents to the survey have an average of nearly 16 years in the saw industry and over 17 years experience in the use of portable circular saws. Four surveys relating to the table and radial arm saws were completed. The four respondents to this survey average over eight years experience in the saw industry and 11 years experience in the use of table and radial arm saws.

The major topics addressed in the surveys were the same for both portable circular saws and table and radial arm saws, i.e.:

1. Electrical safety
2. Blade contact hazards & prevention
3. Accidental ignition
4. Design of saw components
5. Adequacy of instruction manuals

The specific questions in each of these areas were tailored to the different saw types. The following sections summarize responses to the survey items. A sample of the survey form and tabulation of answers to each of the questions are presented in Appendices C and D. Because the respondents sometimes gave multiple answers, or at times did not respond to a particular item, the stated number of responses to a question may not equal the number of respondents.

3.1 Summary of Survey Responses: Portable Circular Saws

3.1.1 Electrical Safety

The portable circular saw survey addressed two topics relevant to the electrical safety of saws: methods of assuring electrical integrity and the use of ground fault interrupters.

3.1.1.1 Assurance of Electrical Integrity

Most manufacturers now make both double insulated and three-wire grounded portable circular saws. Survey respondents were asked which type they preferred for their own use and to express the advantages and disadvantages of each. Eleven respondents preferred double insulated tools while only one preferred three-wire grounding. Two respondents had no preference. The most commonly expressed advantage of double insulation was the ready availability of appropriate receptacles, i.e., ungrounded two-pronged receptacles. Use of double insulated tools, it was noted, requires no user initiated action to assure electrical integrity. Two respondents also noted that cord and plug sets on these tools can be replaced by amateurs without danger of misconnection. The disadvantages of double insulation centered on the fact that metal parts of the saw can become conductive if the saw cuts into an external power source such as a live wire or the power cord of the saw itself. Other disadvantages mentioned included the opinions that double insulated tools were somewhat less durable and more prone to damage in handling, were generally more expensive and might give the user a false sense of security.

Opinions concerning grounded saws most often involved the problem of not being assured of the integrity of the ground even when three-pronged receptacles are available. For the most part, the advantages and disadvantages of three-wire grounding were the converse of those for double insulation. Thus, advantages expressed included the fact that grounding provides protection in the event the power cord or other live wire is cut, more rugged construction materials can be used for the saw housing and manufacture is less expensive.

3.1.1.2 Ground Fault Interrupters

The introduction of ground fault interrupters (GFI's) to home electrical circuits is predicated on the premise that they provide an additional margin of safety when electrical equipment is used. The manufacturers were asked to rate the extent of this added safety when using double insulated

and grounded saws. There was general agreement about the improved safety of grounded saws which are integrated with a GFI, 13 respondents believed the introduction of a GFI would moderately or greatly increase safety. Less unanimity was evidenced concerning the impact of GFI's on double insulated saws. Seven respondents replied that a GFI would provide a moderate or great increase in safety, while six others thought the GFI would add no safety or maginal improvement at best.

3.1.2 Blade Contact Hazards and Prevention

Included in this section are summaries of the responses to questions dealing with kickback prevention, braking systems, blade guards and blade changing.

3.1.2.1 Kickback Prevention

Kickback was the most frequently reported accident pattern in the CPSC IDIR summaries. Informal consultation with representatives of PTI have indicated that the saw industry as a whole has devoted much effort to the kickback hazard. Therefore, a series of questions was asked on this topic.

Many portable saws employ a so-called "slip clutch" as a means of reducing kickback. When asked to rate the effectiveness of this device in reducing the hazard, three respondents suggested that they were very effective, seven somewhat effective, one relatively ineffective and three of no use. When asked to expand on the reasons for their ratings, there was general agreement that while a slip clutch may reduce the probability of some kickbacks, thus providing some margin of safety, there exists a major problem of adjustment. That is, it is difficult to adjust the clutch such that the torque necessary to cut wood is provided but, at the same time, this torque can be overcome if the blade binds. It was also noted that the clutch does not necessarily react quickly enough in the event of a very fast kickback.

Another approach to the kickback problem is the addition of a riving knife or kerf guide to the saw. Many European saws incorporate this device but most American saws do not. Therefore, we questioned the engineers on what they felt were the advantages and disadvantages of riving knives. Ten respondents suggested that a riving knife does reduce kickbacks (one of whom said it eliminates kickbacks) and three also noted that it provides additional guarding for the rear of the blade. All but two respondents, however, made mention of serious adjustment problems when using a riving knife. These problems stem from the fact that saw blades manufactured in the United States are not standardized in terms of width or the set of the teeth. To be functional, the riving knife must be slightly thicker than the face of the blade but thinner than the kerf. Since blades vary considerably in width, the matching of blades and knife becomes impractical. Problems also arise when the riving knife is not exactly aligned with the blade. Two respondents suggested that saw users would likely remove the riving knife. One manufacturer, which does incorporate riving knives on its saws, indicated that approximately 90 percent of saws returned for factory service had the riving knife removed.

Another possible disadvantage of riving knives was suggested by two respondents who claimed that the lower blade guard would be weakened by the slot necessitated by the knife. The guard would be weakened to the extent that the saw would no longer pass the drop test requirements of UL45. Finally, three respondents noted the increased cost of adding riving knives to saws.

A final issue related to kickbacks involved the extent to which dull blades contribute to accidents in general and kickbacks especially. Three respondents thought that for accidents as a whole dull blades were a major cause, six said they contribute to a moderate amount of accidents and four thought dull blades contribute only to a limited extent. By way of contrast, dull blades were thought to contribute to kickbacks as follows: major cause-six, moderate amount-five, limited extent-two. Asked to specify ways in which a novice operator might be alerted that his blade is dull, most respondents recommended including the warning signs in the instruction manual. One respondent, however, suggested the possibility of employing a low cost force transducer that would excite a light emitting diode (LED) when the blade became too dull for safe and efficient use.

3.1.2.2 Braking Systems

A series of questions indirectly related to kickbacks but more directly concerned with the general problem of blade contact was asked regarding systems designed to quickly stop the blade. When asked to give opinions on the merits of electronic brakes, which are activated when trigger pressure is removed, all but one respondent mentioned some advantages. These advantages were expressed in very general terms such as "provides fast stop," "reduces risk from coastdown injuries" and "provides back-up if guard fails." Nine respondents also noted that electronic brakes greatly increase wear on motor components. Six of the engineers suggested that the technology currently available for these brakes makes them unreliable. Other negative aspects of electronic brakes included the expense involved, the violent action of the brake which may startle the operator and the opinion that no braking system currently available is fast enough to prevent kickbacks.

Asked to suggest alternative braking systems which might be considered for protecting the user against kickbacks, seven respondents questioned the value of any type of brake, and three recommended some kind of mechanical system. The possibility of a system in which the blade is disconnected from the motor and gear drive and a system which employs a brake operated by an inertia switch was also suggested.

3.1.2.3 Blade Guards

Blades on portable circular saws are currently guarded by a stationary, permanently attached top guard and a retractable lower guard which opens as the blade enters the work and closes when the blade is clear of the wood. Most respondents considered the guarding requirements of UL45 to be adequate. Only one respondent replied favorably to the possibility of extending the top guard beyond present requirements to prevent forward entry

of the operator's fingers. Negative responses centered around the reduction in visibility introduced by such an extension and problems of clearance for certain miter cuts. The saw engineers were equally negative concerning the possibility of incorporating a stop of some kind to prevent raising the lower guard above the shoe or saw table. Four respondents saw no advantage to the addition of a stop and four suggested that it would only be effective for very shallow cuts since, in the present design configuration, the guard does not raise above the shoe when deeper cuts are made.

All but one respondent considered the present UL requirement for a maximum time for the bottom guard to retract when removed from the work to be valuable. Most agreed with the 0.3 second time allowed by UL45.

For a few operations, e.g., pocket cutting, it is necessary to retract the blade guard manually before starting the cut. Respondents were asked, therefore, to comment on the best location of the assist lever used to raise the guard. Most respondents described configurations consistent with UL45. The primary consideration was that the lever be in a position which minimizes the possibility of contacting the face of the blade.

3.1.2.4 Blade Lock

Respondents were asked to rate the importance, in terms of safety, of a blade locking system to facilitate blade changing. Nine members of the sample thought such a device to be of minor or no importance while four thought it moderately or very important. One respondent suggested that it might be important for home saw users but not for professionals. The major reason for giving low ratings for the value of a blade lock was that blade changing can be accomplished safely without such a device as is evidenced by the lack of reported accidents related to changing the blade.

3.1.3 Accidental Starting

Survey respondents were nearly evenly split on their opinions of the feasibility of designing a starting system which would guard against accidental triggering by children. Of those who accept the feasibility of this approach, the majority of respondents favored a system employing a multistep ignition process or a locking device when the saw is not in use. Some sentiment was also expressed for incorporating stronger trigger pressure or longer switch travel which would make it more difficult for children to start the saw.

3.1.4 Other Design Considerations

A series of questions relating to the design of various saw features not previously discussed was included in the survey.

3.1.4.1 Shoe Design

Survey respondents were unanimous in the opinion that a full or wraparound shoe design is safer for the average home saw user than a half-shoe design. The advantages of a full shoe lie in the additional protection

it provides from blade contact and the added support and control of the saw. However, half-shoes do have the advantage of allowing cuts closer to walls and other obstructions. Opinion was split on the value of a removeable shoe design. Seven respondents saw little or no advantage while five recommended the versatility of a "convertible" shoe which allows the benefits of both full and half shoe designs.

3.1.4.2 Auxiliary Handles

Responses were varied to the question related to operations for which an auxiliary handle or knob is appropriate. These ranged from all sawing operations (three responses) and in particular ripping (four reponses), to those instances in which the saw is used on other than flat surfaces or when extra control is needed (five responses). Most respondents agreed that an auxiliary handle is at least somewhat important as a safety device.

3.1.4.3 Cord Length and Location

UL45 specifies a minimum cord length of six feet. Nine respondents thought this an adequate length for safe saw use. Five others, however, recommended lengths from 18 in to 15 ft (45.7 to 457.2 cm). A majority of respondents agreed that an extensions cord is necessary for most operations regardless of cord length.

The primary factors determining the location of cord entry into the saw were said to be to minimize the possibility of cutting the cord and to provide for ease of saw operation.

3.1.4.4 Rip Fence

The rip fence or guide provided with most portable circular saws as either standard equipment or as an option was considered by most respondents to be a convenience item. None considered it a safety feature.

3.1.4.5 Noise

Asked to rate the noise level of portable circular saws, eight respondents thought the noise emitted was high (one said excessively high) and six believe it to be acceptable. Several respondents noted that most of the noise is generated by the saw blade cutting through the wood, not by the saw motor. Only five respondents considered a noise standard to be helpful for saw designers.

3.1.5 Adequacy of Instruction Manuals

There was general agreement that the instruction manuals which accompany the saws need improvement both in terms of the written material and graphics. Most respondents believed graphics should be used for the major sawing and maintenance operations. The importance of effective instructions is well recognized by the survey respondents. Most, in fact, suggested that a lack of thorough reading of the manuals may be an important contributory factor in power saw accidents.

3.2 Summary of Survey Responses: Table and Radial Arm Saws

3.2.1 Electrical Safety

Table and radial arm saws are generally grounded and require the use of three-pronged plugs. None of the survey respondents felt any benefit would be realized by using double insulation for these saws. Present grounding techniques were regarded to be adequate from a safety standpoint. The introduction of a ground fault interrupter into circuits where grounded stationary saws are used was viewed by two respondents as providing a moderate increase in safety. One respondent thought only a marginal improvement would be realized and the fourth felt that the benefits of GFI's were as yet unknown.

3.2.2 Blade Contact Hazards and Prevention

3.2.2.1 Kickback Prevention

Most table and many radial arm saws are equipped with splitters, or spreaders, and anti-kickback fingers. Splitters are designed to prevent kickbacks by keeping the kerf open while the wood is being cut. Anti-kickback fingers are designed to negate the effect of a kickback, i.e., to stop the wood from being thrown back at the operator. The effectiveness of both of these devices in preventing injury from kickbacks was rated slightly higher for table saws than for radial arm saws. Three respondents rated anti-kickback fingers on table saws as moderately effective. On radial arm saws this device was rated moderately effective by two respondents and relatively ineffective by two others. Table saw splitters were rated very effective in preventing kickbacks by two respondents and moderately effective by one. For radial arm saws two respondents rated splitters moderately effective, one relatively ineffective and one "does not prevent kickback." Only two respondents noted any problems associated with the splitter when blades of varying widths are used. One suggested that the splitter must be slightly thinner than the kerf in order to function properly and the other recommended that splitter thickness should be sized to the thickest blade used. It was also noted that the splitter must be properly aligned with the blade. All respondents rated the task of accomplishing proper alignment as relatively or very easy.

The contribution of dull blades was rated identically for both kickbacks and accidents in general. One respondent thought they were a major cause, one rated dull blades as contributing a moderate amount to accidents and two suggested that they contribute little or not at all to kickbacks and other accidents. These opinions, though from a very small sample, differ markedly from those expressed by portable circular saw manufacturers, most of whom attributed more weight to the role of dull blades in causing kickbacks.

3.2.2.2 Braking Systems

The issue of incorporating a blade braking system on table and radial arm saws is concerned primarily with possible hazards resulting from blade coastdown. Two of three respondents did not consider coastdown to present a hazard for the table saw user. The negative opinions were based on the concept that the duration of coastdown on these saws is only a few seconds and that the blade guard prevents any contact with the blade. The one engineer who believed that coastdown does present a hazard noted that the saw user may reach for the cut wood or scrap before the blade stops. For radial arm saws, which generally have a longer coastdown time than table saws, two respondents believed coastdown is a hazard and two did not. The reasons for these opinions were essentially the same as those noted for table saws. Two respondents felt the establishment of a maximum time for coastdown to be completed would be advantageous, one recommended 15 seconds and the other thought the time should be dependent on blade size.

Asked to specify the type of braking system they would prefer for their own use, two respondents replied none for table saws and the third suggested an "automatic brake." It is not exactly clear what is meant by automatic in this instance beyond some system which is not user initiated. The four respondents replying to the same question in relation to radial arm saws each gave a different response, i.e., manual, electronic, automatic and none.

Survey respondents were asked to state the advantages and disadvantages of manual and electronic brakes for table and radial arm saws. Overall, the engineers were more receptive to incorporating a brake on radial arm saws than on table saws. The major advantage attributed to electronic brakes was that they require no operator initiated action beyond turning off the power switch. This advantage, however, was offset by the increased cost introduced by electronic brakes and the opinion that they are subject to malfunction. While manual brakes were consider cheaper and more reliable, several respondents noted that they would likely not be used by many saw owners. Almost no advantages were expressed for brakes of any kind on table saws.

3.2.2.3 Blade Guards

Most table saws currently on the market are equipped with floating, spreader mounted basket-type blade guards usually constructed of clear plastic. Two respondents recommended this type of guard as being the best for all crosscutting and ripping operations and suggested that it is the best all around guard for home workshop use. This type of guard cannot be used for non-saw-through (e.g., dadoing) or resawing operations. For these procedures one respondent suggested a "barrier type guard" and the other recommended a table mounted guard. A third respondent recommended a hinged overhead guard, covering the top and sides of the blade, that tilts with the saw table and moves up and down with the wood for all operations. Custom

fitted tunnel guards were recommended by one respondent for repetitive sawing operations and the importance of dado and molding table inserts to support the work and minimize the blade contact area for these special operations was noted.

The retractable leaf guards, which cover the periphery of the blade, often found on radial arm saws, were rated moderately effective by two respondents and relatively ineffective by two others. One respondent suggested that fully enclosed, see-through side guards are more appropriate and one recommended tunnel guards for repetitive sawing operations.

3.2.2.4 Blade/Arbor Lock

Respondents were unanimous in the opinion that no advantage would be gained from the inclusion of a blade or arbor lock to facilitate blade changing. The present, commonly employed procedure in which two wrenches are used to change blades was generally supported. One respondent noted that a blade or arbor lock could become accidentally engaged when the saw was running, resulting in wear or failure of motor parts.

3.2.3 Accidental Starting

All respondents felt that present saw designs provide adequate protection against accidental starting of the saw by children. The UL Standard for Stationary and Fixed Electric Tools (UL 987)[1] requires that a tool shall be provided with a means for locking the motor-control switch in the off position. Such a locking system was the method of choice for making saws "child-resistant" by all respondents except one who suggested there was no need for this precaution.

3.2.4 Other Design Considerations

A series of questions related to other design features not previously discussed were included in the survey.

3.2.4.1 Adjustment Interlock

Asked if it was technically feasible to design an interlock system which would prevent adjustments from being made while the saw was running, one respondent replied positively and two responded negatively. There was unanimity in the opinion that such an interlock would be undesirable in that it would severely limit the use of the saw and provide an insignificant advantage for much added expense and the potential for failure.

3.2.4.2 Sawdust Removal

No respondents evaluated a vacuum system for sawdust removal on table saws as a safety feature, rather it was viewed as a convenience item. The

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[1]Standard for Stationary and Fixed Electric Tools, UL987, Second Edition, August 1, 1972, Underwriters Laboratories, Inc.

sawdust ejection feature on radial arm saws, on the other hand, was said to be a safety feature by two respondents. Of interest is the fact that one respondent felt that such a feature is unnecessary and another had the opposite view that it is a necessity.

3.2.4.3 Rip Fence

Unlike the rip fence used on portable saws, the rip fence employed with table and radial arm saws was rated as a necessary safety feature. All respondents agreed that the rip fence was reasonably or very easy to attach and align properly and was also convenient to use.

3.2.4.4 Separate Motors

In terms of overall operational safety, two respondents regarded as reasonably safe the practice of marketing saws and motors separately. One respondent considered this practice hazardous. Although no reason was expressed for this opinion, it is assumed that the hazard referred to involves the possible lack of skill and/or knowledge on the part of the individual who installs his own motor.

3.2.4.5 Radial Arm "Safety Return"

Some radial arm saws incorporate a system whereby the cutting head automatically returns to a position behind the fence when the feed handle is released. This is accomplished either by gravity or a spring system. None of the survey respondents rated this feature as safe, two felt it is slightly unsafe and two rated it hazardous. The primary reason cited for these ratings was the loss of operator control of the cutting head. It was also noted that the so-called safety return may be fatigue inducing, because the effort required to pull the saw through a crosscut is increased.

3.2.4.6 Radial Arm Grip (Feed Handle) Design

The most important consideration given by saw engineers in designing the feed handle on radial arm saws is operator comfort. Safety and comfort, of course, need not be mutually exclusive.

3.2.4.7 Accessories/Options

Very few optional features or accessories were recommended for the novice operator of table or radial arm saws. Two respondents did recommend the addition of a miter gauge for table saws and a variety of special purpose blades and cutters so that the consumer can take advantage of the versatility of radial arm saws.

3.2.4.8 Noise

A consensus was not reached on the subjective evaluation of noise levels for table or radial arm saws. Ratings ranged from high to low. Similarly,

the respondents were evenly split on the question of the usefulness of noise standards. Two believed they would be helpful and 2 thought they would not.

3.2.5 Adequacy of Instruction Manuals

In general, respondents to the table and radial arm saw survey rated the instruction manuals which accompany the saws as satisfactory, although some need for improvement was recognized. These ratings were somewhat higher than those for portable saw manuals. Generally the manuals for stationary tools are more thorough than those for portable tools due in part to the greater assembly requirements for stationary tools and the more complex operations which may be performed with these tools.

4.0 Discussion

4.1 Limitations of the Saw Surveys

Before discussing the major issues raised in the power saw surveys, several limitations of the surveys should be addressed. First, it must be remembered that all of the opinions expressed in the survey responses are those of individuals whose jobs are directly tied to the design, manufacture and distribution of saws now in the marketplace. This point is not raised to cast any aspersions on the integrity of the respondents. The degree of cooperation and openness which has been afforded NBS by that portion of the saw industry which was involved has been considerable. Some degree of bias, however, is likely inescapeable and should be recognized. It may be to CPSC's advantage, therefore, to obtain additional opinions of other saw experts not directly associated with the power saw industry, e.g., consumer groups, professional users and instructors. This would, of course, require some modification of the surveys to include issues which could be addressed by these individuals.

The number of respondents to the surveys was quite small. In the case of the portable circular saw (14 respondents) a substantial portion of the industry was represented. There were four respondents to the table and radial arm saw survey. One of these answered, with a few exceptions, only the questions dealing with radial arm saws. Thus, only three individuals consistently responded to items related to table saws. While this number is small, PTI estimated that the companies represented hold approximately 85 to 95 percent of the stationary saw market.

With the advantage of hindsight, it appears that table and radial arm saws might better have been addressed with two separate survey instruments because of their unique designs and performance capabilities. Also, throughout the course of the investigation more effort was devoted to portable circular saws. The survey dealing with these tools was, therefore, more complete and in some areas less ambiguous than the survey concerned with stationary saws.

The majority of the items included in the surveys dealt directly with the design of power saws. A thorough evaluation of power saw safety also must consider the interaction between the saw and the saw user and should not exclude the use environment. While this interaction was implied in several of the questions and alluded to in many of the reponses, the surveys did not directly address user behavior. The behavior of saw users was to have been the major focus of the observational phases of the investigation which, as noted previously, were terminated before completion.

4.2 Accident Data

Information about the role of the saw operator is often not included, except in very general terms, in the accident data. The most specific data about power saw accidents reviewed during the course of this project were those involving portable circular saws and unspecified stationary saws. The most revealing facet of these data is that which relates to the accident patterns involved in the incidents. While this information does give clues to possible hazards with power saws, there are many important considerations which do not appear in the injury reports. Excluded from most of the accident data are both specific information about the saw and the behavior of the victim which resulted in the injury. The physical characteristics of the wood or other material being cut, the condition of the saw blade and the general condition of the saw itself are important, but usually unknown, elements in the occurrence of any power saw related injury. On the human side, the seemingly elementary question, "What did the victim do?" is often left unanswered. That the vital role of the victim is usually not well specified is not necessarily the fault of the data collection instrument or of the interviewer. In many instances the victim himself may not be able to remember or clearly detail his actions immediately preceeding an accident. Nonetheless, the lack of specific data does limit the researchers and the equipment designers in their ability to draw conclusions which can be applied to the requirements for safer products.

4.3 Saw Design Issues

For the most part, the responses to the saw surveys are self-explanatory and require little in the way of further discussion. Several issues, however, do deserve further consideration in light of their importance to safe saw operation. The most significant problem associated with both portable and stationary saws is kickback. This conclusion is drawn from the accident reports and the reported opinions of the power saw manufacturers. Saw designers have attempted to deal with this problem in a variety of ways. These include the use of slip clutches, electronic brakes and riving knives on portable saws and splitters and anti-kickback fingers on stationary saws. All of these approaches received some measure of support from the respondents to the saw surveys but none were seen as the complete solution to the kickback problem. The riving knife merits special attention in this regard. Most of the survey respondents were in agreement that this device reduces the probability that a kickback will occur. The opinions expressed regarding the positive aspects of riving knives, however,

were over ridden by two negative factors. The first was stated as a technical problem pertaining to the proper sizing and adjustment of the knife when different saw blades are used. A second obstacle to the incorporation of riving knives concerned the issue of consumer acceptance. The opinion expressed by several respondents (as well as other saw manufacturers not surveyed) that neither the American consumer nor the professional saw user will use a riving knife appears to be based upon some limited experience in the United States and the experiences of European saw manufacturers that currently do employ this device. Although this belief that consumers will not accept riving knives as currently available may be valid, it is also conceivable that if the technical problems with the knives can be overcome consumers may be more willing to accept this device. Given the extent of the kickback problem and the potential reduction in kickbacks which could be realized, the issue of riving knives should be studied more thoroughly. More generally, a research and development effort aimed at providing unique means to prevent kickback would appear to be a highly worthwhile pursuit.

In addition to the problem of kickbacks, there are several other areas in which saws may be deficient from a design standpoint. Most important among these are guarding, accidental activation of the saw and the "safety return" employed on some radial saws. Hazards associated with these, however, are not well defined in the accident data.

The question of guarding may not have been satisfactorily addressed in the saw surveys. UL45 currently allows a maximum blade exposure of 25 degrees below the shoe (10 degrees if there is no outboard section of the shoe when the retractable guard is fully extended. The guard must extend at least to the root of the blade teeth. Above the shoe the blade may be exposed a maximum vertical distance of 1 1/2 inches. European standards require the moveable guard to totally enclose the face of the blade, with a maximum of 10 degrees blade exposure. Manufacturers have suggested that such guarding would reduce visibility of the blade as it enters the material being cut and would introduce clearance problems for some miter cuts. It has been suggested that these limitations would be unacceptable to the consumer. In support of this notion, one European manufacturer stated that the European guarding has been met with negative comments from professional saw users in the United States. These comments are based on the lack of visibility which infringes on the handling practices of the professional user. Less is known, however, about the opinions of the non-professional user. An investigation of consumer acceptance of European type guarding in the United States or alternatively a study of European experiences with consumer acceptance of these guards would be beneficial to the clarification of the guarding question.

Accidental or unexpected operation of a cutting tool clearly can present a serious hazard to the operator or to children playing with a saw. Stationary tools manufactured in compliance with UL 987 are required to provide the capability for locking the power switch in the off position. Although all survey respondents felt that this requirement provides adequate

protection against accidental starting of the saw, it should be noted that the consumer may be required to provide his own lock. Voluntary standards for portable saws do not include a locking requirement. While the argument can legitimately be made that portable saws should not be left unattended where children might have access to them, it is clear that this is not always the case. Some portable saws do incorporate a means of protecting against accidental starting through the use of a multi-step switch. These switches require two distinct operations to activate the saw. In addition to protecting children, these switches also protect the intended users when they are carrying or moving the saw.

A final issue related to a specific design feature of saws concerns the incorporation of a so-called "safety return" on some radial arm saws. This feature returns the cutting head to a position behind the fence when the feed handle is released after a crosscut is completed. Although this feature may provide benefits in terms of convenience in production sawing operations, the potential hazards resulting from lack of operator control of the cutting head seem too great to justify including an automatic return on saws for consumer use.

4.4 Are Saws Safe?

Based on the results of the opinion surveys and discussions with saw manufacturers, several generalizations can be made concerning the saw industry's opinions related to saw safety. On the whole, saw manufacturers consider their products to provide adequately for the safety of the user. The manufacturers do recognize, however, that some potentially hazardous situations, notably kickbacks, may be encountered when using a power saw. While reduction in the number of kickbacks may be achievable by modifications in saw design, there is a general feeling among the engineers that the interests of saw safety can best be served by improving the skills and safety habits of saw users. The opinion was repeatedly expressed that as more mechanical and/or electrical "safety features" are added to power saws the chances of failures which can result in additional hazards are increased. If proper use of the saw is the best protection a difficult question still remains. How can proper use of power saws be assured? The educational materials and safety and operating instructions which accompany saws have not been sufficient to guarantee that saws will be used in the safest manner.

In conclusion, it appears that the power saw industry is relatively satisfied with the state-of-the-art with regard to the safety of their products. However, they do indicate that there is some need for improvement in two major areas. These are kickback prevention and user instruction. In addition, this project has brought to light some questions with regard to guarding, riving knives, unintentional starting and user information. In order to adequately address these problems the following research endeavors should be considered:

1. A research and development project to develop means to reduce injuries associated with kickback.

2. A consumer acceptance test of both riving knives and more extensive guards.

3. An evaluation of the potential hazards associated with accidental starting of portable circular saws and the means to deal with them.

4. An investigation into improvement of user information techniques which would involve not only content but also methods to induce the user to read, remember, and use the information.

APPENDIX A

Glossary

The following definitions of terms used in the text are provided for the reader unfamiliar with power saws and saw use:

Anti-kickback fingers - a mechanical device for gripping wood to prevent it from being thrown toward the saw operator in the event of a kickback. Commonly found on table and radial arm saws. See Figures 2 and 3.

Bevel cut - any cut made at other than a right angle to the horizontal plane of the wood. See Figure 4.

Crosscut - a cut made across the grain of the wood. See Figure 4.

Dado - a non saw-through operation which consists of cutting a rectangular groove across the grain of a board. Dados can be accomplished by making multiple cuts with a single saw blade or with the use of special dado cutting heads.

Double insulation - a system of insulating power tools which uses a second or "protecting" insulation system intended to protect the user from a shock in case of failure of the functional insulation. Construction of double insulated tools varies from all metal exterior housings to those having all exterior housings made of plastic.

Ground fault interrupter (GFI) - a device designed to detect electrical ground faults and break the circuit when a fault occurs.

Kerf - the slit or notch made by a saw blade. Also, the width of the cut made by a saw.

Kickback - the violent reaction of the wood or saw which may occur when the saw blade binds in the wood. Several conditions may cause a kickback. The most common of these occurs when the kerf closes on the saw blade.

Leaf guard - a commonly used blade guard on radial arm saws. This type of guard covers only the periphery of the blade and floats over the material being cut. See Figure 3.

Non saw-through operations - any of a variety of cutting operations in which a portion of a board is cut out but not sawed into two pieces, e.g., dados, rabbits.

Resawing - ripping a board so the thickness is reduced or so that it is made into two thinner pieces. See Figure 4.

Rip fence - on portable circular saws, an attachment which serves as a guide for making straight rips of a premeasured width. See Figure 1. Used to guide the stock when making ripping cuts on a table saw. See figure 2.

Ripping - cutting with the grain of the board. See Figure 4.

Riving knife - an anti-kickback device on some portable circular saws. The riving knife consists of a metal splitter blade (non-cutting) which trails the saw blade to prevent the kerf from closing.

Shoe - the base of a portable saw. Three basic types of shoes are available on these saws: full or wraparound shoe - extends completely around the saw housing (See Figure 1); half-shoe - base is only on the inboard side of the saw; removeable shoe - outboard portion of shoe can be removed for making cuts close to an obstruction.

Slip clutch (kickproof clutch) - relieves motor strain and guards against burnout, also designed to protect the operator from possible kickbacks if the blade binds.

Splitter (spreader) - an anti-kickback device consisting of a metal blade mounted behind the saw blade to prevent the kerf from closing. See Figure 2.

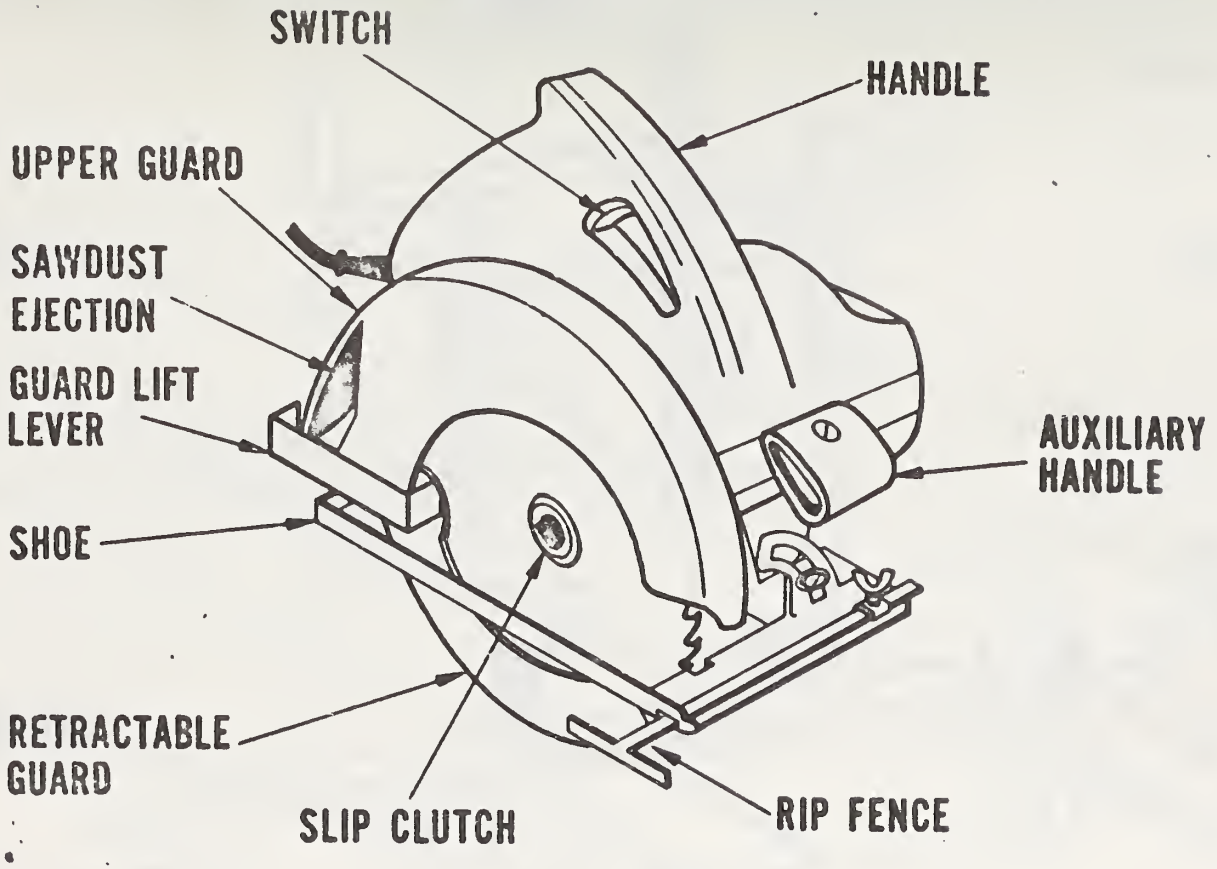

Figure 1. Portable circular saw with components labeled.

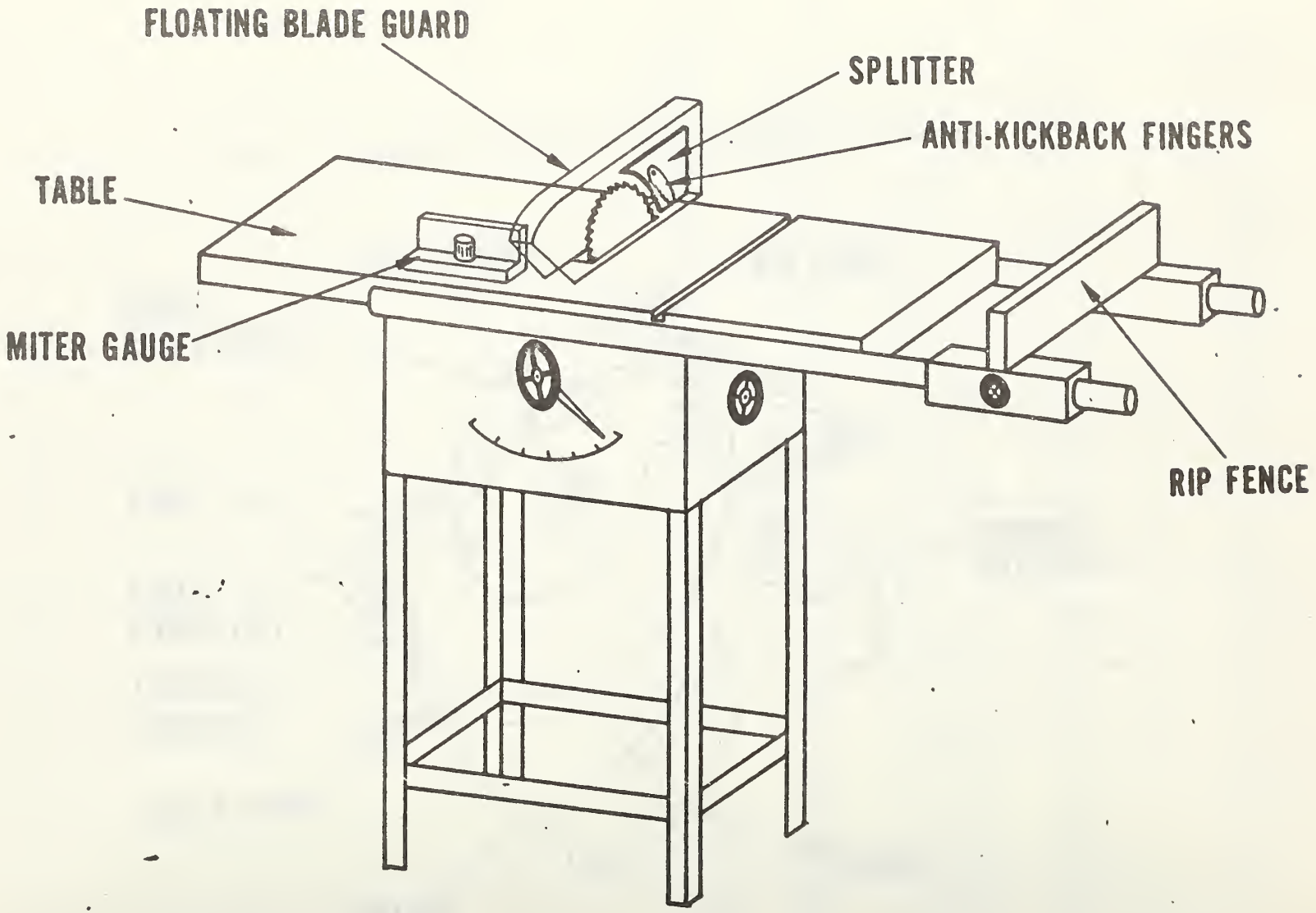

Figure 2. Table saw with components labeled.

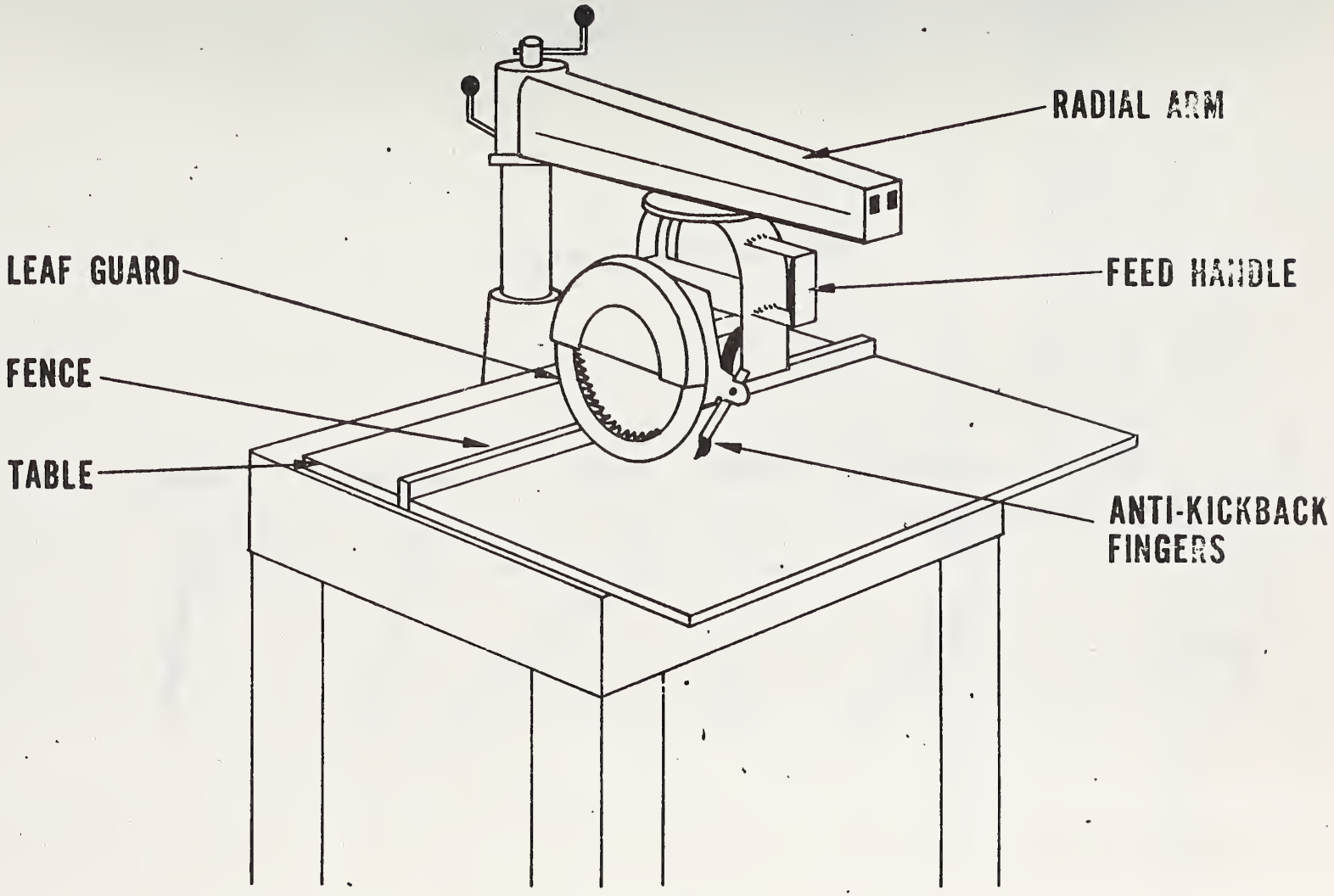

Figure 3. Radial arm saw with components labeled.

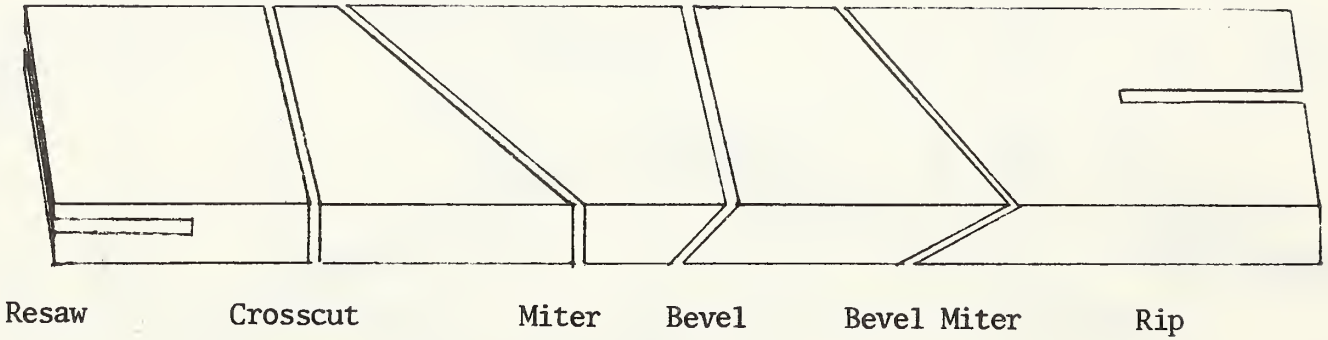

Figure 4. Basic saw cuts.

APPENDIX B

Additional NEISS Accident Data

Distribution of Power Saw Accident Victims By Age and Sex

Table 1A - Unspecified Power Saws
Table 1B - Non-Circular Portable Saws
Table 1C - Stationary Saws
Table 1D - Portable Circular Saws

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis

Table 2A - Unspecified Saws
Table 2B - Non-Circular Portable Saws
Table 2C - Stationary Saws
Table 2D - Portable Circular Saws

TABLE 1A

Distribution of Power Saw Accident Victims By Age and Sex
Unspecified Power Saws
(NEISS, FY 1973)

Age	Male	Female	Total	Percent of Distribution	Percent of U.S. Population**
0-4	12	1	13	1.2	8.4
5-14	80	14	94	8.4	20.0
15-24	220	14	234	21.0	17.4
25-34	216	8	224	21.1	12.2
35-44	160	5	165	14.8	11.4
45-54	136	9	145	13.0	11.4
55-64	117	4	121	10.7	9.2
65+	114	4	118	10.6	9.9
Total	1055	59	1114	*	*
Percent of Distribution	94.7	5.3	100		

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 1B

Distribution of Power Saw Accident Victims By Age and Sex
Non-Circular Portable Saws
(NEISS, FY 1973)

Age	Male	Female	Total	Percent of Distribution	Percent of U.S. Population**
0-4	0	0	0	0.0	8.4
5-14	13	1	14	10.0	20.0
15-24	28	0	28	20.0	17.4
25-34	20	0	20	14.3	12.2
35-44	33	2	35	25.0	11.4
45-54	16	1	17	12.1	11.4
55-64	17	1	18	12.9	9.2
65+	8	0	8	5.8	9.9
Total	135	5	140	*	*
Percent of Distribution	96.4	3.6	100		

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 1C

Distribution of Power Saw Accident Victims By Age and Sex
Stationary Saws
(NEISS, FY 1973)

Age	Male	Female	Total	Percent of Distribution	Percent of U.S. Population**
0-4	0	0	0	0.0	8.4
5-14	10	1	11	7.9	20.0
15-24	43	3	46	32.9	17.4
25-34	17	1	18	12.7	12.2
35-44	20	0	20	14.3	11.4
45-54	23	0	23	16.4	11.4
55-64	13	1	14	10.0	9.2
65+	8	0	8	5.7	9.9
Total	134	6	140	*	*
Percent of Distribution	95.7	4.3	100		

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 1D

Distribution of Power Saw Accident Victims By Age and Sex
Portable Circular Saws
(NEISS, FY 1973)

Age	Male	Female	Total	Percent of Distribution	Percent of U.S. Population**
0-4	0	0	0	0.0	8.4
5-14	5	2	7	7.9	20.0
15-24	20	2	22	24.7	17.4
25-34	11	1	12	13.5	12.2
35-44	10	0	10	11.2	11.4
45-54	13	0	13	14.6	11.4
55-64	7	1	8	9.0	9.2
65+	17	0	17	19.1	9.9
Total	83	6	89	100.0	*
Percent of Distribution	93.2	6.7	*		

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 2A

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
Unspecified Power Saws
(NEISS, FY 1973)

Body Part Injured	Diagnosis: Laceration	Amputation	Fracture	All Others	Total	Percent of Distribution*
Hand	123	0	2	4	129	11.6
Finger	675	42	37	39	793	71.2
Arm	30	1	0	3	34	3.0
Upper Leg	32	0	0	1	33	3.0
Lower Leg, Feet, Toe	72	0	1	7	80	7.2
Trunk	9	0	1	3	13	1.2
Eye	1	0	0	14	15	1.3
Head and Neck	12	0	0	5	17	1.5
Total	954	43	41	76	1114	100
Percent of Distribution	85.6	3.9	3.7	6.8	100	

* 1970 U.S. Census.

TABLE 2B

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
Non-Circular Portable Saws
(NEISS, FY 1973)

Body Part Injured	Laceration	Amputation	Electric Shock	Fracture	All Others	Total	Percent of Distribution**
Hand	12	0	0	0	0	12	8.6
Finger	75	6	0	2	8	91	65.0
Arm	3	0	0	0	3	6	4.3
Upper Leg	7	0	0	0	1	8	5.7
Lower Leg, Feet, Toe	10	0	0	0	1	11	7.8
Trunk	2	0	0	0	1	3	2.1
Eyes	0	0	0	0	2	2	1.4
Head and Neck	6	0	1	0	0	7	5.0
Total	115	6	1	2	16	140	*
Percent of Distribution	82.1	4.3	0.7	1.4	11.4	*	

* Percentages do not necessarily add to 100% due to rounding error.

** 1970 U.S. Census.

TABLE 2C

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
Stationary Saws
(NEISS, FY 1973)

	Diagnosis					
Body Part Injured	Laceration	Amputation	Fracture	All Others	Total	Percent of Distribution
Hand	12	0	0	0	12	8.6
Finger	96	4	4	8	112	80.0
Arm	3	0	0	0	3	2.1
Upper Leg	3	0	0	0	3	2.1
Lower Leg, Feet, Toe	3	0	2	2	7	5.0
Trunk	0	0	1	1	2	1.4
Head and Neck	1	0	0	0	1	0.7
Total	118	4	7	11	140	*
Percent of Distribution	84.3	2.8	5.0	7.8	*	

* Percentages do not necessarily add to 100% due to rounding error.

TABLE 2D

Distribution of Injuries Related to Power Saw Use By Body Part Injured and Diagnosis
Portable Circular Saws
(NEISS, FY 1973)

	Diagnosis					
Body Part Injured	Laceration	Amputation	Fracture	All Others	Total	Percent of Distribution
Hand	12	0	0	1	13	14.6
Finger	48	7	2	5	62	69.7
Arm	4	0	0	0	4	4.5
Upper Leg	3	0	0	0	3	3.4
Lower Leg, Feet, Toe	3	0	1	0	4	4.5
Trunk	1	0	0	0	1	1.1
Eye	0	0	0	2	2	2.2
Head and Neck	0	0	0	0	0	0.0
Total	71	7	3	8	89	100
Percent of Distribution	79.8	7.9	3.4	9.0	*	

* Percentages do not necessarily add to 100% due to rounding error.

APPENDIX C1

Portable Circular Saw Survey Form

OMB 41-S-74105
Approval Expires June 30, 1975

OPINION SURVEY
PORTABLE CIRCULAR SAWS

GENERAL INSTRUCTIONS:
FOR EACH OF THE FOLLOWING QUESTIONS, PLEASE BRIEFLY STATE YOUR OWN PERSONAL OPINIONS. WE ARE NOT INTERESTED IN YOUR COMPANY'S STAND--ONLY YOUR OWN THOUGHTS ABOUT THE SAFETY ASPECTS OF POWER SAWS. PLEASE KEEP THIS IN MIND WHEN ANSWERING QUESTIONS ABOUT HYPOTHETICAL SITUATIONS CONCERNING THE "IDEAL" SAW. ALTHOUGH WE REALIZE THE LIMITATIONS IMPOSED BY THE CURRENT STATE-OF-THE-ART, WE ARE INTERESTED IN YOUR BEST JUDGEMENTS ABOUT THE SAFE USE AND DESIGN OF POWER SAWS. PLEASE FEEL FREE TO MAKE ADDITIONAL COMMENTS IN THE MARGINS OR IN THE SPACE PROVIDED AT THE END OF THE QUESTIONNAIRE.

1. Which type of connection would you prefer on a saw for you own use: double insulated or three-wire grounding?

_____ Double insulated
_____ Three-wire grounding

1a. In your opinion, what are the advantages of each type of connection for portable circular saws?

a. Double insulated connections: _____

_____

_____

b. Three-wire grounding connections: _____

_____

_____

1b. How about the disadvantages of each?

a. Double insulated: _____

_____

_____

b. Three-wire grounding: _____

_____

_____

2. It is generally accepted that the introduction of ground fault interrupters to home electrical circuits provides an additional margin of safety when electrical equipment is used. How would you rate the extent of this added safety when using double insulated power saws?

_____ Greatly increases safety

_____ Moderate increase in safety

_____ Marginal improvement in safety

_____ No added safety

2a. What about when using three-wire grounded power saws?

_____ Greatly increases safety

_____ Moderate increase in safety

_____ Marginal improvement in safety

_____ No added safety

3. UL 45 specifies a six foot length of cord for circular saws. Do you feel that this length is adequate?

_____ Yes: Why is that? _____

_____

_____ No: What length would you consider adequate?

_____feet.

4. Cord location varies from saw to saw: some cords are located in the base of the handle, some in the side of the grip, etc. What factors do you think should determine the location of the cord on the saw? _____

_____

_____

5. Essentially, what factors do you think should determine the grip design and location on circular saws?

a. Grip design: _____

_____

b. Grip location: _____

_____

5a. Do you have any preference for one design and/or location?

_____

_____

6. Do you think it is feasible for an ignition system to be designed which guards against accidental triggering of the saw by children?

_____ Yes: Have you any suggestions for its design? (General comments, please): _____

_____

_____

_____ No

6a. Which of the following do you feel should be considered as possible methods by which an ignition system could be made "child resistant"?

_____ Strong trigger pressure requirement for all saws

_____ Locking system when saw is not in use

_____ Multi-step ignition process, i.e., several operations to be performed before saw starts

_____ Other (specify) _____

_____

_____ None of the above; no need for such precautions

7. How would you rate the effectiveness of a slip clutch in reducing kickback hazard?

_____ Very effective
_____ Somewhat effective
_____ Slightly ineffective
_____ Of no use

7a. Why do you say that? _____

_____

_____

7b. Would you please list two or three major problems that you have had with such a clutch? _____

_____

_____

_____

8. In your opinion, what are the advantages of an electronic braking system:

_____

_____

_____

8a. How about the disadvantages of an electronic braking system?

_____

_____

_____

9. What other braking systems do you feel might be considered as alternatives for protecting the user against kickbacks? (General comments, please):

_____

_____

_____

10. Of what value do you think that the establishment of a standard time for blade rotation to stop after disengagement of the power switch would be? Why? _____

_____

_____

11. How important is a blade locking system on saws in terms of a safety device for blade changing?

_____ Very important
_____ Moderately important
_____ Minor importance
_____ Not important

11a. Why do you say that? _____

_____

_____

12. Do you regard the sawdust ejection feature on some circular saws as:

_____ Functional
_____ A convenience item
_____ A safety feature
_____ Unnecessary
_____ A necessity

12a. Are you aware of any problems with such a system?

_____ Yes: What kinds of problems? _____

_____

_____

_____

_____ No

13. Where do you think that the assist lever should be located to raise the bottom guard? _____

_____

_____

14. For what operations do you feel that an auxilliary handle or knob is appropriate? _____

_____

_____

14a. If you were to rate the auxilliary handle or knob for its effectiveness as a safety device, would you say that it is:

_____ Very important

_____ Somewhat important

_____ Unnecessary

_____ Not really a safety feature

15. Which shoe design do you consider safer for the average homeowner's use: a full shoe or a half shoe?

_____ Full shoe

_____ Half shoe

15a. What would you say are the major advantages of each type of shoe?

a. Full shoe: _____

_____

_____

b. Half shoe: _____

_____

_____

15b. How about the disadvantages of each one?

a. Full shoe: _____

_____

_____

b. Half shoe: _____

_____

_____

15c. Of what value, if any, is a removeable shoe?

_____

_____

16. Although European models have a riving knife incorporated into their saws, most American manufacturers do not. What do you think are the advantages of a riving knife? _____

_____

_____

16a. What about the disadvantages? _____

_____

_____

_____

16b. What kinds of experiences have you had with a riving knife?

_____

_____

_____

17. When you consider the use of a rip fence by a beginner, would you say that it is primarily: (Mark only <u>one</u> of the below)

_____ A safety feature
_____ A convenience item
_____ A "crutch" which he will learn to do without
_____ A functional necessity
_____ Unnecessary

17a. How would you rate the rip fence in terms of ease of attachment and convenience to use.

_____ Very easy to attach	_____ Very convenient
_____ Moderately easy	_____ Moderately convenient
_____ Somewhat of a bother	_____ Somewhat of a bother
_____ Other (specify)	_____ Other (specify)
_____	_____

17b. What other features, such a guides and accessories, do you think the novice operator should have? _____

_____

_____

18. What total percentage of the blade edge do you think it is feasible to cover by guards? _____

19. What do you think would be the effect of attaching some sort of stop that would prevent the bottom guard from being raised above the shoe?

_____

_____

19a. What about extending the top guard to prevent possible forward entry of the operator's fingers? _____

_____

_____

20. In your opinion, would a standard maximum time for bottom guard retraction be of value?

_____ Yes: What time would you suggest? _____ seconds

_____ No

21. How much do you feel that dull blades contribute to accidents in general and kickbacks specifically?

Accidents	Kickbacks
_____ Major cause	_____ Major cause
_____ Moderate amount	_____ Moderate amount
_____ Limited extent	_____ Limited extent
_____ Little or none	_____ Little or none

21a. A dull blade is made obvious to the experienced saw user by poor quality cut, burning of material, etc. Have you any ideas on ways to alert the casual user that his blade needs to be sharpened or replaced?

_____ Yes: Please explain: _____

_____

_____

_____ No

22. How would you rate the noise levels emitted during the saw's operation?

_____ Excessively high

_____ High

_____ Acceptable

_____ Low

_____ Other (specify) _____

22a. Are there any noise standards that you know of for circular saw operations?

_____ Yes: What are they? _____

_____

_____ No

22b. Do you feel that such a noise standard would be helpful?

_____ Yes _____ No

23. The following questions deal with the instruction or owner's manuals provided with portable saws. Please answer these items based on your familiarity with the manuals in general and your personal opinions of manual effectiveness.

23a. Would you say that the graphics that are frequently used to demonstrate various saw operations are:

_____ Satisfactory
_____ Need improvement
_____ Other (specify) _____

23b. Do you prefer sketches or photographs of the various details and operations that are presented in instruction manuals?

_____ Sketches
_____ Photographs
_____ Other (specify) _____

23c. Would you say that the written instructions in the manuals are:

_____ Satisfactory
_____ Need improvement
_____ Other (specify) _____

23d. For which of the following types of operations do you feel graphic representation should appear in a manual? (Mark as many as you think apply):

_____ Rip cuts
_____ Cross cuts
_____ Pocket cuts
_____ Identification of saw parts
_____ Depth adjustment
_____ Bevel adjustment
_____ Use of rip fence
_____ Cutting large pieces
_____ Maintenance and care
_____ Other (specify) _____

_____

23e. Could you suggest any way to further alert the user to the proper and safe operation of circular saws? _____

_____

_____

23f. How much do you feel that the lack of thorough reading of the instruction manual contributes to accidents? _____

_____

_____

23g. What warnings do you feel should appear on the saw itself?

_____

_____

_____

_____

23h. The manuals of all members of the Power Tool Institute contain a list of safety instructions developed by PTI. Are there any additional instructions or warnings you think should be included?

_____ No

_____ Yes, for example: _____

_____

_____

_____

24. If you have any additional comments or questions or areas not covered in the survey please use the following space. If needed, attach additional sheets. _____

_____

_____

_____

_____

THANK YOU FOR YOUR TIME AND EFFORT IN COMPLETING THIS SURVEY. YOUR OPINIONS AE MOST IMPORTANT TO US AND WILL BE TABULATED WITH THOSE OF THE OTHER RESPONDENTS. NO INDIVIDUAL IDENTITIES OF EITHER RESPONDENTS OR MANUFACTURERS WILL APPEAR IN THE GENERAL SUMMARIES WE PLAN TO DEVELOP.

APPENDIX C2

Tabulation of Responses to Portable Circular Saw Survey

Survey items in this appendix are presented in abbreviated form. See Appendix C1 for complete text.

Tabulation of Survey Responses: Portable Circular Saws

1. Preference:

11 - Double insulated.
1 - Three-wire grounding.
2 - No preference.

1a Advantages:

a. Double insulation:
11 - Appropriate receptacles readily available, no user initiated grounding action required.
2 - Cords and plugs replaceable by amateurs w/o danger of misconnection.
1 - Uneffected in case of internal electrical failure.
1 - Infrequency of reported shock to user.

b. 3-wire grounding:
7 - Provides protection in event cord or other live wire is cut by blade.
5 - Safer, if integrity of ground assured.
3 - Allows use of more rugged construction materials.
1 - Protects against build-up of contaminants.
1 - Cheaper.
1 - No advantages.

1b Disadvantages:

a. Double insulation:
7 - Metal parts can become conductive if external power source contacted.
2 - Less durable, more prone to damage in handling.
2 - May give user false sense of security.
2 - More expensive.
1 - Failure of both insulating systems possible.
1 - Possible for manufacturer to ship defects.
1 - No answer.

b. 3-wire grounding:
12 - Properly grounded receptacles not always available, integrity of ground may not be assured.
4 - Shock hazard if replacement cords and plugs incorrectly wired.
1 - Not protected if ground prong removed or improper extension cord or adapter used.

2. Merits of ground fault interupter:

Double insulated saws	Grounded saws	
1	7	Greatly increases safety
6	6	Moderate increase in safety
3	1	Marginal improvement in safety
3	-	No added safety
1	1	No answer

3. Is 6' cord length adequate:

9 - Yes - Why? - 7 - Need extension cord for most operations.
1 - Adequate for bench operation.
1 - Any standard length will have shortcomings.
5 - No - What length recommended
1 each - 18", 8', 10', 12', 15'.

4. Factors determining cord location:

8 - Minimize possibility of cutting cord.
6 - Provide ease of operation.
3 - Minimize possibility of catching cord on work.
2 - No obstruction to users hands.
1 - Minimize interference with guard operation.
1 - Pulling on cord should not twist saw and bind blade.
1 - Electrical safety and economics.
1 - Provide operator with cord control.
1 - No answer.

5. Factors determining:

a. Grip design:
11 - Comfort.
2 - Prevention of accidental switch activation.
2 - Ease of switch operation.
2 - Positioned for best pushing angle.
3 - Hand size.
2 - "Safety".
1 - Insulated from metal portions of saw.

b. Grip location:
9 - Balance.
3 - Comfort.
3 - Back handle.
2 - 45° from plane of cutting surface.
1 - Visibility.
1 - As close to blade as possible.

5a Preference for grip design/location:

10 - Respondents specified designs consistent with above factors.

6. Feasible to design "child-resistant" ignition system:

8 - Yes.
6 - No.

6a Possible methods for making ignition system "child-resistant":

2 - Strong trigger pressure requirement for all saws.
6 - Locking system when saw is not in use.
6 - Multi-step ignition process, i.e., several operations to be performed before saw starts.
3 - None of the above, no need for such precautions.
1 - Other: longer switch travel.

7. Effectiveness of slip clutch in reducing kickback hazard:

3 - Very effective.
8 - Somewhat effective.
2 - Slightly ineffective.
3 - Of no use.
(one respondent marked each of first 3 alternatives)

7a Reasons for ratings:

Very effective:	2 - Provides margin of safety. 1 - Good, but can be defeated.
Somewhat effective:	2 - Adjustment problems. 2 - Not effective in quick kickbacks. 1 - Reduces but does not eliminate kickbacks. 1 - Can be defeated. 1 - Users must be educated to use clutch properly. 1 - No response.
Slightly ineffective:	1 - Adjustment problems. 1 - Can be defeated.
Of no use:	2 - Adjustment problems. 1 - None currently available that do job.

7b Major problems with slip clutch:

7 - Adjustment.
3 - No problems.
2 - No response.
1 - Reliable designs expensive.
1 - No real slip clutch exists.

8. Advantages of electronic braking systems:

6 - Fast blade stop.
3 - Reduces risk of coastdown injury.
2 - Back-up if guard fails.
2 - Reliable, tamper-proof.
2 - Safer.
1 - No advantages.
1 - No response.

8a Disadvantages of electronic brake:

9 - Wear on motor components.
6 - Unreliable.
3 - Expensive.
2 - Violent action, high arc may startle user.
1 - Defeats slip clutch.
1 - May encourage user carelessness.
1 - Not fast enough to prevent kickback.

9. Alternative braking systems:

8 - Question value of any braking system.
3 - Mechanical brake.
1 - System in which blade disconnected from motor & gear drive.
1 - Interim switch controlled brake.
1 - No answer.

10. Value of standard time for blade stop:

4 - Provides additional safety.
2 - Limited values.
2 - No value.
2 - Not practical.
1 - Very valuable.
1 - Gives industry goal.
1 - Provides back-up if guard fails.
1 - No answer.

11. Importance of blade locking system:

2 - Very important.
3 - Moderately important.
6 - Minor importance.
4 - Not important.

(one respondent checked alternative 2 for home users, alternative 3 for professional.)

11a Reasons for ratings:

Very important:

1 - Lack of such system encourages unsafe blade changing practices.
1 - Ensures proper bolt tension.

Moderately important:

1 - Operator that uses locking device probably would be safe without lock.
1 - Professional doesn't need it, more adept than homeowner.
1 - Personal judgment.

Minor importance:

2 - Saw is not running when blade is changed.
1 - Could add hazard.
1 - Adds unnecessary cost.
1 - Not necessary if user follows safety precaution.
1 - Professional doesn't need it, more adept than homeowner.
1 - Few blade changing accidents.

Not important:

2 - Not necessary if safety precautions followed.
2 - Few or no blade changing accidents.

12. Sawdust ejection feature:

10 - Functional.
3 - Convenience item.
5 - Safety feature.
0 - Unnecessary.
3 - A necessity.

12a Any problems with sawdust ejection system:

9 - No.
1 - No response.
4 - Yes.

Kinds of problems:

3 - Clogging under some conditions, e.g., damp wood.
2 - Misdirection of discharge into users face.

13. Preferred location of bottom guard assist lever:

5 - Long enough to keep fingers away from blade.
2 - Inboard side of top blade guard.
2 - Extended radially beyond outer diameter of upper guard, bent away from open face of blade.
2 - Top rear.
1 - Such that upper guard separates grasping point of lever and blade.
1 - Per UL45.
1 - No response.

14. For what operations is auxilliary handle appropriate:

4 - Ripping operations.
3 - All sawing operations.
2 - When saw is used on other than flat work.
2 - Where extra control is required, e.g., crosscutting narrow pieces.
2 - When using heavy saws.
1 - When accuracy of start is important.
2 - No response.

14a Effectiveness of auxilliary handle as a safety device:

4 - Very important.
5 - Somewhat important.
0 - Unnecessary.
2 - Not really a safety feature.
4 - No response.

(one respondent checked very important for high capacity saws and somewhat important for other saws.)

15. Safer shoe design for home use:

12 - Full shoe.
0 - Half shoe.
2 - No response.

15a Advantages of shoe types:

a. Full shoe:
10 - Provides additional protection from blade contact,
9 - Provides additional support, control, stability,
2 - Permits use of miter guide,
1 - Improves cutting accuracy.
3 - No response.

b. Half shoe:
10 - Permits cuts closer to obstructions.
1 - Permits better visibility.
1 - Lighter weight.
1 - Less expensive.
3 - No response.

15b Disadvantages of shoe types:

a. Full shoe:
7 - Cannot cut close to obstructions.
1 - Slightly poorer visibility.
1 - More expensive.
1 - Heavier.
1 - Damage to shoe could effect guard operation.
3 - No response.

b. Half shoe:
10 - Provides less protection.
6 - Provides less stability, support.
1 - Decreased accuracy of cut.

15c Value of removeable shoe:

7 - Very little or no value.
5 - Additional versatility, allows advantages of both full and half shoe designs.
3 - No response.

16. Advantages of riving knife:

9 - Reduces kickback.
3 - Provides additional guarding of rear of blade.
2 - No advantages.
1 - Eliminates kickback.
2 - No response.

16a Disadvantages of riving knife:

11 - Adjustment problems due to variable saw blade thickness etc.
3 - Added cost.
2 - Users likely to remove.
2 - Weakens lower guard.
1 - Difficult to make pocket cuts.
1 - Less visibility.
1 - Learning problem for novices.
2 - No response.

16b Experience with riving knife:

4 - Limited or no personal experience.
3 - Used for evaluation purposes.
3 - Positive, promotes confidence in kickback prevention.
1 - 90% of returned saws minus riving knife.
1 - Binding in rip cuts.
2 - No response.

17. To novice saw user, rip fence is primarily:

0 - Safety feature.
11 - Convenience item.
2 - Crutch which user will learn to do without.
1 - Functional necessity.
0 - Unnecessary.

17a Rip fence ratings:

Ease of attachment	Convenience of use
4 - Very easy.	4 - Very convenient.
8 - Moderately easy.	6 - Moderately convenient.
1 - Somewhat of a bother.	2 - Somewhat of a bother.
1 - No answer.	2 - No answer.

17b Other features, accessories novice should have:

3 - None.
4 - Good instructions.
2 - Miter guide.
2 - Good extension cord.
2 - Proper wrench for blade changing.
1 - Various blades.
1 - Vacuum pickup.
1 - Safety glasses.
1 - Plastic window to view blade position.
2 - No response.

18. Total percentage of blade feasible to cover by guards:

6 - 80-85%.
3 - 90-95%.
2 - 75-80%.
2 - Per UL45.
1 - No response.

19. Effect of incorporating a stop to prevent raising bottom guard above shoe:

4 - No advantage.
4 - Only effective for very shallow cuts, otherwise guards already function in this way.
2 - Likely to be removed by user.
1 - Contribute to saw safety if made adjustable.
3 - No response.

19a Effect of extending top guard:

5 - Introduces visibility problems.
3 - Present guarding standards adequate.
2 - Introduces clearance problems for miter cuts.
1 - Technical disadvantages.
1 - Receptive to idea.
2 - No response.

20. Is standard maximum time for bottom guard retraction valuable:

1 - No.
1 - No response.
12 - Yes.

Time recommended

8 - .3 sec.
2 - .5 sec.
2 - No response.

21. Contribution of dull blades to accidents:

	In general	Kickbacks
Major cause	3	6
Moderate amount	6	5
Limited extent	4	2
Little or none	0	0
No response	1	1

21a Ideas about how to alert casual saw user that blade is dull:

10 - Through instructions.
1 - Use of low cost force transducer that would excite LED.
2 - Have no ideas.
1 - No response.

22. Noise level ratings:

1 - Excessively high.
7 - High.
6 - Acceptable.
0 - Low.
1 - No response.

22a Are you aware of any noise standards for circular saws:

6 - No.
1 - No response.
7 - Yes.

What Standards

4 - OHSHA.
3 - PTI test method.
2 - Local or company.

22b Would noise standards be helpful:

7 - No.
5 - Yes.
2 - No response.

23. Adequacy of instruction manuals:

23a Adequacy of graphics:

5 - Satisfactory.
8 - Need improvement.
1 - No response.

23b Preference in graphics:

7 - Sketches.
4 - Photographs.
1 - Both.
1 - No preference.
1 - No response.

23c Adequacy of written instructions:

2 - Satisfactory.
11 - Need improvement.
1 - No response.

23d Graphic representation should appear in manuals for:

10 - Rip cuts.
10 - Crosscuts.
11 - Pocket cuts.
12 - Identification of saw parts.
11 - Depth adjustment.
11 - Bevel adjustment.
11 - Use of rip fence.
7 - Cutting large pieces.
10 - Maintenance and care.

Other (specify)

2 - Use of miter guide.
2 - Types of blades.
2 - Changing blades.
1 - Sharpening blades.
1 - Recognition of dull blades.
1 - Use of riving knife.

1 - No response.

23e Way to further alert user to proper and safe saw operation:

4 - Provide warnings about unsafe practices.
3 - Make instruction manuals unique, alert saw owner to use them.
3 - Provide audio visual aides, posters etc.
2 - Provide more information about proper techniques.

23f How much does lack of thorough reading of manuals contribute to accidents:

12 - Contributing factor.
2 - Not contributing factor.

23g What warnings should appear on the saw itself:

6 - Consult operators manual.
3 - Check blade guard.
2 - Disconnect plug when changing blade.
2 - Grounding instructions.
2 - Tool dangerous if used improperly.
1 - Keep blade sharp.
1 - As required by UL45.
1 - As many as possible.
1 - Cannot put all warnings on saw.

23h Recommendations for additional warnings in manual beyond those PTI members now include:

11 - No.
3 - Yes.

2 - Warning re grounding operator.
1 - Warnings re improper connections when changing cord set.

APPENDIX D1

Table and Radial Arm Survey Form

OMB 41-S-74105
Approval Expires June 30, 1975

OPINION SURVEY
TABLE AND RADIAL ARM SAWS

GENERAL INSTRUCTIONS:
FOR EACH OF THE FOLLOWING QUESTIONS, PLEASE BRIEFLY STATE YOUR OWN PERSONAL OPINIONS. WE ARE NOT INTERESTED IN YOUR COMPANY'S STAND--ONLY YOUR OWN THOUGHTS ABOUT THE SAFETY ASPECTS OF POWER SAWS. PLEASE KEEP THIS IN MIND WHEN ANSWERING QUESTIONS ABOUT HYPOTHETICAL SITUATIONS CONCERNING THE "IDEAL" SAW. ALTHOUGH WE REALIZE THE LIMITATIONS IMPOSED BY THE CURRENT STATE-OF-THE-ART, WE ARE INTERESTED IN YOUR BEST JUDGEMENTS ABOUT THE SAFE USE AND DESIGN OF POWER SAWS. PLEASE FEEL FREE TO MAKE ADDITIONAL COMMENTS IN THE MARGINS OR IN THE SPACE PROVIDED AT THE END OF THE QUESTIONNAIRE.

1. Kickbacks are involved in many of the injuries associated with table saws. How would you rate the effectiveness of anti-kickback fingers in preventing injury from a kickback on a table saw?

_____ Very effective
_____ Moderately effective
_____ Relatively ineffective
_____ Provides no protection
_____ Introduces additional hazard (specify) _____

1a. How would you rate the anti-kickback fingers commonly found on radial arm saws?

_____ Very effective
_____ Moderately effective
_____ Relatively ineffective
_____ Provides no protection
_____ Introduces additional hazard (specify) _____

2. Would you briefly describe the functions of a splitter (or spreader) on table and radial arm saws?

a. Table Saw: _____

_____

_____

b. Radial Arm Saw: _____

_____

_____

2a. How would you rate the effectiveness of a splitter/spreader in preventing kickbacks on table and radial arm saws?

Table Saws	Radial Arm Saw
_____ Very effective	_____ Very effective
_____ Moderately effective	_____ Moderately effective
_____ Relatively ineffective	_____ Relatively ineffective
_____ Does not prevent kickbacks	_____ Does not prevent kickbacks

3. Can you think of any other ways to protect the user from kickbacks, especially when the splitter/spreader would not be attached as is sometimes the case for table saws? _____

_____

_____

4. Do you know of any problems that have arisen with the splitter/spreader when blades of varying widths have been used? (Please explain briefly):

_____

_____

_____

4a. Any other problems? _____

_____

5. The splitter/spreader has to be removed for some operations and then re-attached to the table saw. How difficult do you think it is for the novice user to properly align the splitter/spreader with the blade after such operations?

_____ Extremely difficult for the novice
_____ Moderately difficult
_____ Relatively easy
_____ Very easy

6. If you were going to purchase a splitter/spreader for your own use, what kind of material would you prefer it to be made of? Why is that?

_____

_____

_____

7. A blade guard is standard equipment on almost all table saws. Different types of guards, however, may be more or less appropriate for specific sawing operations. In terms of the safest operating conditions possible, please describe what, in your opinion, would be the best type of guard for each of the following operations:

Operation	Type of Guard
Cross-cutting short or medium length stock	_____
Cross-cutting long stock	_____
Ripping narrow boards	_____
Ripping large plywood sheets	_____
Non saw-thru operations, e.g., dadoing	_____
Resawing	_____

7a. Are there any other types of guards that you feel are appropriate for special operations?

_____ Yes: Please describe the operation and type of guard:

_____

_____

_____

_____ No

5. The splitter/spreader has to be removed for some operations and then re-attached to the table saw. How difficult do you think it is for the novice user to properly align the splitter/spreader with the blade after such operations?

_____ Extremely difficult for the novice
_____ Moderately difficult
_____ Relatively easy
_____ Very easy

6. If you were going to purchase a splitter/spreader for your own use, what kind of material would you prefer it to be made of? Why is that?

_____

_____

_____

7. A blade guard is standard equipment on almost all table saws. Different types of guards, however, may be more or less appropriate for specific sawing operations. In terms of the safest operating conditions possible, please describe what, in your opinion, would be the best type of guard for each of the following operations:

Operation	Type of Guard
Cross-cutting short or medium length stock	_____
Cross-cutting long stock	_____
Ripping narrow boards	_____
Ripping large plywood sheets	_____
Non saw-thru operations, e.g., dadoing	_____
Resawing	_____

7a. Are there any other types of guards that you feel are appropriate for special operations?

_____ Yes: Please describe the operation and type of guard:

_____

_____

_____

_____ No

9a. Do you think that this blade rotation presents any hazard to the radial arm saw user?

_____ Yes: Why? _____

_____

_____ No: Why not? _____

_____

9b. In your opinion, would there be any advantages to establishing a maximum allowable braking time for such situations?

_____ Yes: What would you suggest? _____ seconds

_____ No: Why not? _____

_____

10. What type of braking system would you prefer to have on a saw for your own use?

For Table Saws	For Radial Arm Saws
_____ Manual	_____ Manual
_____ Electronic	_____ Electronic
_____ Other _____	_____ Other _____
_____ None	_____ None

10a. Please list what you feel are two or three of the major advantages and disadvantages of manual brakes for table saws:

a. Advantages: _____

_____

_____

b. Disadvantages: _____

_____

_____

10b. What would you say are the major advantages and disadvantages of an electronic brake on a table saw?

a. Advantages: _____

_____

_____

b. Disadvantages: _____

_____

_____

10c. What kinds of problems and advantages are you aware of when a manual brake is used on a radial arm saw?

a. Advantages: _____

_____

_____

b. Disadvantages: _____

_____

_____

10d. What about when an electronic brake is used on a radial arm saw?

a. Advantages: _____

_____

_____

b. Disadvantages: _____

_____

_____

11. It appears that most table and radial arm saws have three-wire grounding connections. Do you feel that it would be of any benefit to use double insulated connections for these saws?

_____ Yes _____ No

11a. Why do you feel that way? _____

_____

_____

_____

12. It is generally accepted that the introduction of ground fault interrupters to home electrical circuits provides an additional margin of safety when electrical equipment is used. How would you rate the extent of this added safety when using double insulated power tools?

_____ Greatly increases safety
_____ Moderate increase in safety
_____ Marginal improvement in safety
_____ No added safety
_____ Benefits of GFI's unknown

12a. What about when using three-wire grounded power saws?

_____ Greatly increases safety
_____ Moderate increase in safety
_____ Marginal improvement in safety
_____ No added safety
_____ Benefits of GFI's unknown

13. Do you think that present saw designs provide adequate protection against accidental triggering of the saw by children?

_____ Yes _____ No

13a. Which of the following do you feel should be considered as methods by which saws could be made "child resistant"?

_____ Strong pressure requirement to activate switch
_____ Multi-step ignition process; i.e., several operations must be performed before saw starts
_____ Locking system when saw is not in use for all saws
_____ Other (specify) _____

_____

_____ None of the above; no need for such precautions

13b. Would you prefer a locking device that is an integral part of the ignition switch (i.e., something built into the switch) or one that is external (i.e., such as a separate lock)?

_____ Prefer lock that is part of the switch
_____ Prefer lock that is external to the switch
_____ Other (specify) _____

13c. How important would you rate ease and convenience of locking and unlocking saws as related to using such a device?

_____ Very important
_____ Slightly important
_____ Doesn't matter
_____ Other (specify) _____

14. When you consider the use of a rip fence by a beginner, would you say that it is primarily: (Mark all that apply).

_____ A safety feature
_____ A convenience item
_____ A "crutch" which he will learn to do without
_____ Unnecessary
_____ A necessity
_____ Other (specify) _____

14a. How would you rate the rip fence on a table saw in terms of ease of attachment and convenience of use?

_____ Very easy to attach	_____ Very convenient to use
_____ Reasonably easy	_____ Reasonably convenient
_____ Somewhat of a bother	_____ Somewhat of a bother
_____ Other (specify)	_____ Other (specify)
_____	_____

14b. Would you say that aligning the rip fence on a table saw is:

_____ Relatively easy

_____ Somewhat difficult

_____ Requires great concentration to properly align

_____ Other (specify) _____

15. What optional features, such as guides and accessories, etc. would you suggest for the novice operator of (a) table saws; and (b) radial arm saws?

a. Table saws: _____

_____

b. Radial arm saws: _____

_____

16. In your opinion, would there be any advantages to having a blade or arbor lock that would restrain the blade during changing?

_____ Yes _____ No

16a. Why do you say that? _____

_____

_____

17. Is it technically feasible to design an interlock system that would prevent adjustments being made to a saw while the blade is rotating?

_____ Yes _____ No

17a. What is your opinion on the desirability of such a system?

_____

_____

_____

18. How much do you feel that dull blades contribute to accidents in general and kickbacks specifically?

Accidents	Kickbacks
_____ Major cause	_____ Major cause
_____ Moderate amount	_____ Moderate amount
_____ Limited extent	_____ Limited extent
_____ Little or none	_____ Little or none

18a. A dull blade is made obvious to the experienced saw user by poor quality cut, burning of material etc. Have you any ideas on ways to alert the casual user that his blade needs to be sharpened or replaced?

_____ Yes: Please explain: _____

_____

_____

_____ No

19. Do you regard the sawdust ejection feature on radial arm saws as:

_____ Functional
_____ A convenience item
_____ A safety feature
_____ Unnecessary
_____ A necessity
_____ Other (specify) _____

19a. How about a vacuum system for removal of debris on table saws: do you feel that this is:

_____ Functional
_____ A convenience item
_____ A safety feature
_____ Unnecessary
_____ A necessity
_____ Other (specify) _____

20. Table saws are often purchased without motors; the buyer supplies his own. How would you rate this practice in terms of over-all operational safety?

_____ Very safe
_____ Reasonably safe
_____ Somewhat unsafe
_____ Hazardous
_____ Other (specify) _____

21. How would you rate the noise levels emitted during operation of a table saw?

_____ Excessively high
_____ High
_____ Acceptable
_____ Low
_____ Other (specify) _____

21a. How about the noise on radial arm saws?

_____ Excessively high
_____ High
_____ Acceptable
_____ Low
_____ Other (specify) _____

21b. Are there any noise standards that you know of for stationary saw operations?

_____ Yes: What are they? _____
_____
_____ No

21c. Do you feel that a standard of this kind would be (is) helpful?

_____ Yes _____ No

22. Briefly, what factors do you think should determine the grip (feed handle) design and location on radial arm saws?

Grip design: _____

_____

Grip location: _____

_____

22a. Do you have any preference for one design and/or location? Why?

_____

_____

23. How would you rate the safety return feature available on some radial arm saws?

_____ Very safe
_____ Reasonably safe
_____ Slightly unsafe
_____ Hazardous
_____ Other (specify) _____

23a. Why do you say that? _____

_____

_____

24. The following questions deal with instruction or owner's manuals provided with stationary saws. Please answer these items based on your familiarity with the manuals and your personal opinions about their effectiveness.

24a. Would you say that the graphics that are used to demonstrate various saw operations are:

_____ Satisfactory
_____ Need improvement
_____ Other (specify) _____

24b. Do you prefer sketches or photographs of the various details presented in instruction manuals?

_____ Sketches
_____ Photographs
_____ Other _____

24c. Would you say that the written instructions in the manuals are:

_____ Satisfactory
_____ Need improvement
_____ Other (specify) _____

24d. For which of the following types of operations do you feel graphic representation should appear in a manual:

_____ Rip cuts
_____ Cross cuts
_____ Pocket cuts
_____ Identification of saw parts
_____ Depth adjustment
_____ Bevel adjustment
_____ Use of rip fence
_____ Use of miter gage
_____ Resawing
_____ Rabbiting
_____ Dadoing
_____ Cutting large pieces
_____ Maintenance and care
_____ Other (specify) _____
_____

24e. Could you suggest any ways to further alert the user to the proper and safe operation of table and radial arm saws? _____

_____

_____

_____

24f. How much do you feel that the lack of thorough reading of the instruction manual contributes to accidents? _____

_____

_____

24g. What warnings do you feel should appear on the saw itself?

_____

_____

_____

_____

24h. The manuals of all members of the Power Tool Institute contain a list of safety instructions developed by PTI. Are there any additional instructions or warnings you think should be included?

_____ No

_____ Yes, for example: _____

_____

_____

_____

25. If you have any additional comments on questions or areas not covered in the survey please use the following space. If needed attach additional sheets.

_____

_____

_____

_____

_____

_____

_____

_____

THANK YOU FOR YOUR TIME AND EFFORT IN COMPLETING THIS SURVEY. YOUR OPINIONS ARE MOST IMPORTANT TO US AND WILL BE TABULATED WITH THOSE OF THE OTHER RESPONDENTS. NO INDIVIDUAL IDENTITIES OF EITHER RESPONDENTS OR MANUFACTURERS WILL APPEAR IN THE GENERAL SUMMARIES WE PLAN TO DEVELOP.

APPENDIX D2

Tabulation of Responses to Table and Radial Arm Survey

Survey items in this appendix are presented in abbreviated form. See Appendix D1 for complete text.

Tabulation of Survey Responses: Table and Radial Arm Saws

1. Effectiveness of anti-kickback fingers on table saw:

- - Very effective.
3 - Moderately effective.
- - Relatively ineffective.
- - Provides no protection.
- - Introduces additional hazards.

1a Effectiveness of anti-kickback fingers on radial arm saws:

- - Very effective.
2 - Moderately effective.
2 - Relatively ineffective.
- - Provides no protection.
- - Introduces additional hazard.

2. Functions of a splitter on:

a. Table saw:
3 - To keep kerf from closing and pinching blade.

b. Radial arm saw:
4 - To keep kerf from closing and pinching blade.

2a Effectiveness of splitter in preventing kickbacks:

Table Saws	Radial Arm Saws	
2	-	Very effective.
1	2	Moderately effective.
-	1	Relatively ineffective.
-	1	Does not prevent kickbacks.

3. Other ways to protect saw user from kickbacks:

1 - Instructions, good manuals.
1 - Keep blade clean, sharp and in proper alignment.

4. Splitter problems when blades of varying widths used:

1 - Splitter must be slightly thinner than kerf to function properly.
1 - Splitter thickness should be sized for thickest blade used.

4a Other problems with splitter:

1 - Splitter must be properly aligned with blade.

5. Ease of aligning splitter:

- - Extremely difficult for the novice.
- - Moderately difficult.
2 - Relatively easy.
2 - Very easy.

6. Preferred material for splitter, why:

3 - Steel for durability and strength

7. Best type of table saw guard for various operations, safety as only criterion:

Operation	Best guard
Crosscutting short/medium length stock.	2 - Splitter mounted, 1 - hinged overhead. 1 - One that covers all of blade not engaged in cutting.
Crosscutting long stock.	Same responses as above.
Ripping narrow boards.	Same responses as above.
Ripping large plywood sheets.	Same responses as above.
Non saw-thru operations.	1 - Barrier type, 1 - table mounted 1 - One that covers all of blade not engaged in cutting.
Resawing.	Same response as above.

7a What guards appropriate for special operations:

1 - Tunnel guards, custom fit to wood for repetitive operations.
1 - Dado and molding table inserts to support table and minimize blade contact possibility.

7b With safety as only criterion, what is best single guard:

2 - Splitter mounted.
1 - Hinged overhead.
1 - One that would cover all of the blade not engaged in cutting the material.

7c Is above guard impractical for home workshop use:

2 - No
2 - Yes - In what way:

1 - (Splitter mounted) - cannot be used for non saw-thru operations.
1 - (Complete coverage) - would be difficult to adjust for different applications.

7d If limited to one guard, the best in terms of safety, cost, ease of use, versatility and reliability is:

3 - Splitter mounted.
1 - Hinged overhead type.

8. Effectiveness of retractable leaf guards on radial arm saws:

- - Very effective.
2 - Moderately effective.
2 - Relatively ineffective.
- - Increases blade contact hazard.

8a Other types of guards for radial arm saws:

1 - Tunnel guards for repetitive sawing.
1 - Fully enclosed, see-thru side guards.
1 - One that covers all of the blade not engaged in cutting material.
1 - Anti-kickback device.

9. Does coastdown present hazard for table saw user:

1 - Yes - User may reach for work or scrap before blade stops.
2 - No - Coastdown duration only a few seconds, guard should protect.

9a Does coastdown present hazard for radial arm saw user:

2 - Yes - Operator may reach for work or scrap, blade can move if contact made with saw table.
2 - No - Coastdown time is very short, "danger zone" is readily obvious.

9b Any advantages to establishing a maximum braking time:

2 - Yes - 1 - 15 seconds.
1 - Time depends on blade size.
1 - No - Manual braking more appropriate.

10. Preferred braking systems:

For table saw	For radial arm saw	
-	1	Manual
-	1	Electronic
1 (automatic)	1 (automatic)	Other
2	1	None

10a Advantages & disadvantages of manual brakes for table saws:

a. Advantages:
3 - No advantages.
1 - Cheaper, possibly more reliable.

b. Disadvantages:
1 - Hand must be near moving blade to operate, brake parts may be propelled like projectiles, mechanism must be complex to function in any tilt or elevation position.
1 - Probably wouldn't be used regularly.
1 - Brake not necessary on table saw.

10b Advantages & disadvantages of electronic brakes for table saws:

a. Advantages:
   2 - No advantages.
   2 - Takes braking function out of users hands.

b. Disadvantages:
   2 - Expensive.
   1 - Greater possibility of malfunction.
   1 - Brake not necessary on table saws.

10c Advantages & disadvantages of manual brakes for radial arm saws:

a. Advantages:
   1 - Relatively inexpensive.
   1 - Keeps operator occupied till blade stops.
   1 - Simple, uses no power when not is use.
   1 - More reliable.

b. Disadvantages:
   2 - May not be used.
   2 - Hand reaches toward blade to operate.

10d Advantages & disadvantages of electronic brakes for radial arm saws:

a. Advantages:
   3 - Requires no operator initiated action.
   1 - No advantages.

b. Disadvantages:
   1 - Costly.
   1 - Can spin off blade.
   1 - Does not keep operator occupied until blade stops.

11. Any benefits from using double insulation for table and radial arm saws:

   4 - No - If integrity of ground is assured grounding is best.

12. Extent of added safety provided by GFI's when using double insulated tools:

   - - Greatly increases safety.
   - - Moderate increase in safety.
   1 - Marginal improvement in safety.
   2 - No added safety.
   1 - Benefits of GFI's unknown.

12a Extent of added safety provided by GFI's when using grounded saws:

   - - Greatly increases safety.
   2 - Moderate increase in safety.
   1 - Marginal improvement in safety.
   - - No added safety.
   1 - Benefits of GFI's unknown.

13. Do present saw designs provide adequate protection against accidental triggering of saw by children:

4 - Yes
0 - No

13a What methods should be considered for making saws "child-resistant":

- - Strong pressure requirement to activate switch.
- - Multi-step ignition process.
3 - Locking system when saw is not in use for all saws.
- - Other
1 - None of the above, no need for such precautions.

13b Preference for type of switch lock:

2 - Prefer lock that is part of the switch.
1 - Prefer lock that is external to the switch.
- - Other.

13c Importance of ease and convenience of locking and unlocking saws as related to using the device:

2 - Very important.
1 - Slightly important.
- - Doesn't matter.
- - Other.

14. Use of rip fence by novice saw user:

3 - A safety feature.
1 - A convenience item.
- - A "crutch" which he will learn to do without.
- - Unnecessary.
3 - A necessity.
- - Other.

14a Table saw rip fence ease of attachment and convenience of use:

2 - Very easy to attach.	2 - Very convenient to use.
1 - Reasonably easy.	1 - Reasonably convenient.
- - Somewhat of a bother.	- - Somewhat of a bother.
- - Other.	- - Other.

14b Alignment of table saw rip fence:

3 - Relatively easy.
- - Somewhat difficult,
- - Requires great concentration to properly align.
- - Other.

15. Recommended optional features and accessories for novice operator:

a. Table saws:
2 - Miter gauge, fence.
1 - Sanding disk, dado blades.
1 - Saw stand.

b. Radial arm saws:
2 - Special purpose blades and cutters.
1 - Saw stand.

16. Any advantage to blade or arbor lock for blade changing:

4 - No
0 - Yes

16a Why:

2 - Present 2 wrench system adequate.
1 - Could become accidentally engaged, resulting in wear or failure of parts.

17. Is it technically feasible to design an interlock system that would prevent adjustment:

1 - Yes
2 - No

17a Desirability of interlock system:

3 - Not desirable.
1 - Would limit use of saw.
1 - Insignificant advantage for added expense and potential failure.

18. Contribution of dull blades to accidents:

	In general	Kickbacks
Major cause	1	1
Moderate amount	1	1
Limited extent	-	-
Little or more	2	2

18a Ideas about how to alert casual user that blade is dull:

1 - Save and display sample cut from new blade for comparison.
1 - Inspection of edge of teeth and set will advise.

19. Sawdust ejection feature on radial arm saws:

1 - Functional.
1 - A convenience item.
2 - A safety feature.
1 - Unnecessary.
1 - A necessity.
- - Other.

19a Vacuum system for removing debris on table saws:

- - Functional.
3 - A convenience item.
- - A safety feature.
1 - Unnecessary.
- - A necessity.
- - Other.

20. Operational safety of table saws purchased without motor, user supplies power source:

- - Very safe.
2 - Reasonably safe.
- - Somewhat unsafe.
1 - Hazardous.
- - Other.

21. Noise level ratings - table saws:

- - Excessively high.
1 - High.
1 - Acceptable.
1 - Low.
- - Other.

21a Noise level ratings - radial arm saws:

- - Excessively high.
1 - High.
2 - Acceptable.
1 - Low.
- - Other.

21b Are you aware of any noise standards for stationary saw operation:

3 - Yes - 2 - OSHA
1 - ANSI 01.1 - 1971
1 - No

21c Would noise standards be helpful:

2 - Yes
2 - No

22. Factors determining grip (feed handle) design and location on radial arm saws:

a. Grip design:
3 - Comfort.
1 - Functional.
1 - Conform to hand and arm of operator

b. Grip location:
1 - Away from immediate cutting area.
1 - In line with natural arm/body relation.
1 - Functional.

22a Preference for one design/location:

2 - No
1 - All known units appear adequate.

23. Rating of "safety return":

- - Very safe.
- - Reasonably safe.
2 - Slightly unsafe.
2 - Hazardous.
1 - Other - unnecessary.

23a Reasons for ratings:

3 - Cutting head may move without operator control.
1 - Fatigue inducing.
1 - Increases effort required to pull saw through material when crosscutting.

24. Adequacy of instruction manuals:

24a Adequacy of graphics:

3 - Satisfactory.
1 - Need improvement.
- - Other.

24b Preference in graphics:

1 - Sketches.
1 - Photographs.
2 - Other - both, line drawings.

24c Adequacy of written instructions:

2 - Satisfactory.
2 - Need improvement.

24d Graphic representation should appear in manuals for:

4 - Rip cuts.
4 - Crosscuts.
4 - Pocket cuts.
4 - Identification of saw parts.
4 - Depth adjustment.
4 - Bevel adjustment.
3 - Use of rip fence.
3 - Use of miter gauge.
4 - Resawing.
4 - Rabbiting.
4 - Dadoing.
4 - Cutting large pieces.
4 - Maintenance and care.
1 - Other - trouble shooting, safety tips.

24e Ways to further alert user to proper and safe operation:

1 - Provide incentive to read instruction manuals.
1 - Include proper type of warning labels.
1 - Recommend attendance at shop courses.

24f How much does lack of thorough reading of manuals contribute to accidents:

1 - Very greatly.
1 - Greatly.
1 - Somewhat.
1 - Significantly for novice.

24g What warnings should appear on the saw itself:

1 - None.
1 - As required by UL 987.
1 - Highly readable warnings at all potentially hazardous locations.
1 - Direction of rip, "make adjustments after saw stops," "make sure all clamps are tight before cutting.

24h Recommendations for additional warnings in manual beyond those PTI members now include:

3 - No.
1 - Yes - Include warnings specific to particular tool, PTI list may be too general.

APPENDIX E

Power Saw Manufacturers Surveyed

Representatives of the following manufacturers participated in the power saw surveys.

Portable Circular Saw Survey

AEG Power Tool Corporation
The Black and Decker Manufacturing Company
Ferrostaal-Metabo Tool Corporation
Millers Falls Company
Milwaukee Electric Tool Corporation
Robert Bosch Corporation
Rockwell International Corporation
The Singer Company
Sioux Tools, Inc.
Skil Corporation
The Stanley Works
Thor Power Tool Company

Table and Radial Arm Saw Survey

De Walt Division of the Black and Decker Manufacturing Company
Emerson Electric Company
Rockwell International Corporation
Toolkraft Corporation

NBS-114A (REV. 7-73)

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4. TITLE AND SUBTITLE

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5. Publication Date: July 1975

6. Performing Organization Code

7. AUTHOR(S): V. J. Pezoldt, J. J. Persensky

8. Performing Organ. Report No.

9. PERFORMING ORGANIZATION NAME AND ADDRESS

NATIONAL BUREAU OF STANDARDS
DEPARTMENT OF COMMERCE
WASHINGTON, D.C. 20234

10. Project/Task/Work Unit No.: 4411423

11. Contract/Grant No.

12. Sponsoring Organization Name and Complete Address (Street, City, State, ZIP)

Consumer Product Safety Commission
Washington, D.C. 20207

13. Type of Report & Period Covered: Final

14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

Two activities of an investigation of power saws are described: a review of power saw injury data and two surveys of saw manufacturers' opinions concerning safety aspects of saw use and design. The injury data reviewed consisted of information from the National Electronic Injury Surveillance System and from summaries of In-Depth Investigation Reports compiled by the Consumer Product Safety Commission. The two surveys, dealing with portable circular saws and table and radial arm saws respectively, were directed toward obtaining the opinions of technical representatives of power saw manufacturers on five major areas of saw use and design, i.e., electrical safety, blade contact hazards and prevention, accidental starting, the design of various saw components and the judged adequacy of saw instruction manuals. Power saw engineers and designers recognize some problems with present saw designs, especially relating to kickbacks. Overall, however, the survey respondents believe saws to be reasonably free from hazards introduced by product design. The area in which the saw manufacturers believe the most hazards to exist is that of the operator's use of power saws. This human element in saw accidents is recognized as a major contributor to saw related injuries, but little is known about how to assure that safe practices will be followed. Areas for further study are suggested.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

Accident research; consumer products; injury data; opinion survey; portable circular saws; power saws; radial arm saws; safety; table saws.

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